The INSTITUTE Spokesman

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OFFICIAL PUBLICATION

NATIONAL LUBRICATING GREASE INST
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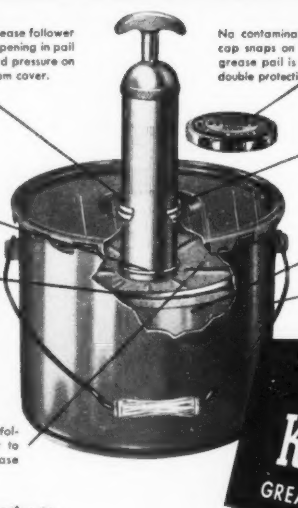
Grease gun fits into grease follower plate through center opening in pail cover. Slight downward pressure on gun releases plate from cover.
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No air bubbles . . . because follower plate maintains uniform pressure on grease during gun loading.
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Pail shipped from factory with follower plate attached to cover to simplify handling during grease packing operations.

Published monthly by
The National Lubricating Grease Institute
Harry F. Bennetts, *Editor*
Joanne Couey, *Assistant Editor*
4638 J. C. Nichols Parkway
Kansas City 2, Mo.

1 Year Subscription ... $2.50
1 Year Subscription (Foreign) ... $3.25

The INSTITUTE Spokesman

Volume XV | Number 12 | March 1952

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ABOUT THE COVER

The cover illustration shows how the structure in an exceedingly thin film of an improved aluminum stearate base lubricating grease looks when magnified 130,000 times by the electron microscope.

Examination by means of the electron microscope has been useful in explaining some of the observed characteristics of many types of lubricating greases. The distinctive fibre characteristics of the various lubricating grease soaps are readily recognized by use of electron micrographs.

In aluminum stearate greases, the particles of aluminum soap are so minute, and their arrangement so tenuous, that many early attempts with the electron microscope failed to demonstrate the presence of significant structure. However, in American Cyanamid laboratories the development of new electron microscopy techniques has resulted in electron micrographs indicating the presence of occasional minute fibrils.

This company reports that lubricating greases made from new, strengthened grades of aluminum stearate are characterized by a predominance of these fibrils, which in many cases are oriented to produce a network. The American Cyanamid Company has a new booklet which is available to the lubricating grease industry. This booklet describes its strengthened grades of aluminum stearate reported to embody the latest advances in scientific research.

President's page

by George E. Merkle, President, N.L.G.I.

THE LUBRICATION ENGINEER

The importance of a real lubrication engineer is well known in some of the large operations in which many pieces of machinery, equipment and bearings are used. Even in such operations there is often room for improvement.

There are, however, multitudes of factories and plants having many lubrication requirements which, in many cases, have not recognized the importance of this part of their operations and consequently have left the job to some careless, or uninformed operator. Frequently we find the man in charge of the oil room is the lubrication engineer. He need not know anything about temperatures, loads, speeds or the merits of the product to be used. If directed by a competent lubrication expert, he could properly apply the correct lubricant at the proper intervals, but without such guidance one cannot expect satisfactory lubrication.

When one considers the cost of the equipment to be lubricated and the possible lost time due to failures resulting from insufficient or improper lubrication, he will realize the importance of lubricants and experienced lubricating engineers.

There have been great strides made in the manufacture of lubricating greases over the past quarter of a century. Greases have been developed to meet many new and difficult requirements. All this was brought by speeding up production and the use of new type machinery having exceptional lubrication requirements. In addition to the very complex lubricants required today, there are severe requirements as to cleanliness and freedom from grit due to the very close clearances to be lubricated. Such special lubricants can only perform best in the hands of experienced lubrication experts.

The importance of lubrication and lubricating greases is slowly being recognized but lags in recognition when compared with the publicity given lubricating oils. Both have their places but certainly greases do not rate second place in importance. We would do well to stress the importance of our industry.

BRABAG SYNTHETIC OIL PLANT AT ZEITZ, GERMANY, was shattered by bombs during World War II. Storage tanks for synthetic oil are masses of twisted wreckage. To help do the impossible in rebuilding the plant, a slave gang of six to seven thousand foreign laborers was moved to Germany from 17 different countries and kept in dispersed concentration camps nearby, ready to attempt repairs after each bombing attack.

U. S. Army A. A. F. Photograph

MIDDLE EAST OIL AND EUROPEAN REFINERIES

DR. GUSTAV EGLOFF, Director of Research, Universal Oil Products Company

ONE of the world's greatest sources of economic wealth is the Middle East oil fields, with an ultimate potential of 200 billion barrels of oil (value over 300 billion dollars). Proved reserves are over 40 billion barrels of oil, about 46 per cent of the world's proved deposits, while the U. S. A. has about 30 billion barrels of proved oil reserves and 100 billion barrels potential. The vast oil richness of the Middle East countries, Iran, Saudi Arabia, Kuwait, Iraq, Qatar and Bahrein, is reflected in the average daily rate of production during 1950 which was 1,700,000 barrels from 315 wells averaging 5400 barrels each. In contrast, the U. S. A. averages 12 barrels a day from its 444,000 producing wells or a total of about 5,400,000 a day.

The Middle East is vastly rich, not only in oil but in history as well. Iran, where the first commercial quantity of crude was produced, has over 6000 continuous years of history covering five civilizations. Thousands of years ago Iran controlled the then-known world. Oil seepages and burning natural gas have been known through all recorded history, but practically nothing was done to utilize these great assets until 1855, when a British geologist reported on the scientific aspects of oil seepages of Iran and Iraq.

Photographs of Europe were contributed by WORLD PETROLEUM. The Anglo-Iranian Oil Company is responsible for the Middle East pictures.

The first drillings for oil in Iran, made in 1891-1893 through British and German capital, ended in failure. In 1901, Iran granted a 500,000-square-mile concession to an Englishman, W. K. D'Arcy, whose company almost went broke before hitting a gusher in 1908 at a depth of 1180 feet in Masjid-i-Sulaiman. This single oil field has produced about 862 million barrels of crude in the past 39 years.

On the basis of this discovery well, the Anglo-Persian Oil Company was formed in 1909 to operate the sixty-year concession given by the Persian government with all rights, responsibilities and obligations involved. Other oil fields were discovered in Iran, and, based upon these results, oil was found in the great Kirkuk field in Iraq in 1927 followed by Bahrein in 1932, Saudi Arabia in 1936, Kuwait in 1938 and Qatar in 1940.

The development of these fields has required vast expenditures not only for oil producing facilities, but for the economic and social development of the Middle Eastern countries. Several billions have been spent, much of which has gone for non-oil producing purposes.

Beginning only 42 years ago, the Anglo-Iranian Oil Company was the pioneer in this vast development. In 1909, the first year of AIOC's operation, the majority of the Iranians were an illiterate, disease-ridden people, living in mud huts along with their animals, and engaged in primitive agriculture. In 1950, AIOC was supporting 200,000 people

in Iran. Abadan has grown from a wilderness to a modern city complete with electric lights, treated water, a sewage system, stores, schools, restaurants, movies, swimming pools and other recreational facilities. The company has built and equipped 30 schools which have been turned over to the educational authorities. These schools are open to the children of non-employees as well as those of employees. About 4000 illiterate adults attend each session of a special school. The company has also equipped Teheran University with laboratories and set up a Technical Institute at Abadan. Many of the best students have been sent to English universities for advanced training. Perhaps the most dramatic improvement has been in health standards. Back in 1909, the country was ravaged by epidemics of plague, cholera, and smallpox; malaria, dysentery and trachoma were endemic. For the past 25 years, there has been no serious outbreak of cholera or plague, and smallpox, malaria, dysentery and trachoma are under control. In 1950, over one and one-half million received attention at AIOC dispensaries and clinics, over one million of whom were non-employees. Without AIOC, Iran woulld still have a largely primitive civilization. It is unfortunate that the Iranian leaders have thrown out those responsible for so much progress.

Similar developments in community building, education and health have taken place in other Middle Eastern countries. For example, about two-thirds of the employees of the Arabian American Oil Company are Arabs. Their employment has required years of training to acquire technical skills as well as literacy. The company has laid out a number of community developments along the Tapline as well as in the fields and at the refinery, and is constructing roads across the desert to link formerly isolated localities. It is also constructing a railroad for the government. Electrical power stations and transmission lines have been built. The company has constructed many buildings for the government and assisted in bringing in mechanized farming, irrigation, and other innovations in an effort to build up domestic industry.

The problems in connection with producing, refining and transporting oil vary with the different countries in the Middle East. The following discussion summarizes the status of the industry in each country.

IRAN

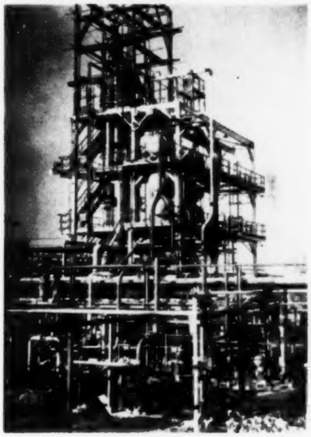
The seven oil fields of Iran cover about 250 square miles of a total concession of 100,000 square miles. Proved reserves are 13 billion barrels. Operations have been carried on exclusively by the Anglo-Iranian Oil Company. The only other active oil company is the Iran Oil Company, formed by the government in 1949 to explore outside AIOC's 100,000-square-mile concession.

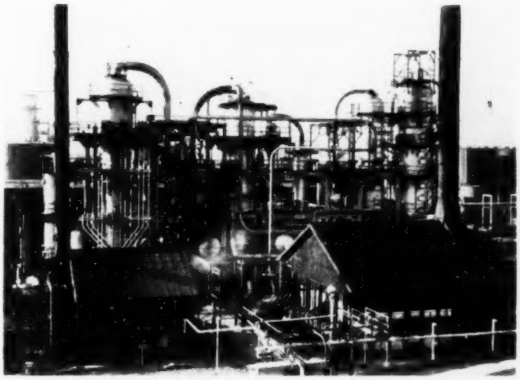
Daily production in 1950 was at the rate of 665,000 barrels from 77 wells, or over 8500 barrels per well per day. The greatest oil field in Iran is the Agha Jari discovered in 1937. At the end of 1950, production was 370,000 barrels a day from 16 wells, or an average of 23,000 barrels per well per day. The gravity of the various crudes ranges from 33 to 43 API, averaging 37.

The depth of wells ranges from about 2000 feet to 5500 feet. Production is from limestone formations of phenomenal thickness, varying from 600 to 1500 feet.

HEAVY BOMBING AND DISMANTLING during World War II greatly reduced the lube-production possibilities of the Standard Francaise des Petroles' Port Jerome refinery in Normandy.

LATEST NEW UNIT to go on stream at Port Jerome is the recently completed deasphalting plant.





THIS NEW PHENOL PLANT at Port Jerome replaces war-destroyed facilities.

The flow from wells having pressures around 2000 p. s. i. has been very carefully controlled so that pressure drops are about five pounds per well per year. Excess gas was pumped back into the formation. The most modern techniques known to science were used. It is believed that 90 per cent of the oil in the formations can be recovered. The result is long-lived fields — as witness the Masjid-i-Sulaiman which, after 39 years, is producing an average of 2100 barrels per well per day.

The pipeline system is interlaced from field to field to the Abadan refinery and Bandar Mashur, both export terminals. The modern refinery at Abadan, the largest in the world, is a complete one which processed about 560,000 barrels of crude into 90,000 barrels a day of motor fuel, 18,000 barrels a day of aviation gasoline, as well as kerosene, Diesel oils and jet fuel. Operations included a 35,000-barrel-a-day fluid catalytic cracking plant, three alkylation units and a 400-barrel-a-day lubricating oil plant, and others.

One of the most important segments of the Anglo-Iranian Oil Company's operations is transportation. It owns one of the world's largest tanker fleets consisting of about 160 ocean-going tankers and charters another 160 ocean-going tankers, having a carrying capacity of two million dead weight tons of oil, and chartering another two million tons— or a total of four million tons.

Very little oil is required for the 18 million people in Iran, and about 97 per cent of the crude oil and refined products produced in Iran has been exported. All exportation is dependent upon shipping and thus the tanker fleet is a vital part of their world-wide operation.

It is unfortunate that the highly integrated and efficient operations of AIOC in Iran have been lost to the world even if only for a temporary period of time. It is hoped that efforts being made toward a satisfactory solution to the problem will soon restore the Anglo-Iranian production of refined and crude oil to world markets.

IRAQ

The geological conditions of Persia were found to be continued into Iraq. This called for further exploration, which resulted in the discovery of the great Kirkuk field in the year 1927, although production was not commenced until the latter part of 1934. The land area of Iraq is about 116,000 square miles and has a population of five million. The proved oil reserves of eight and one-quarter billion

PETROLEUM REFINERIES AT GIRONDE, FRANCE, are damaged after bombings of 1944.

barrels occupy an area of 132 square miles. There were ten wells, producing 159,000 barrels daily at the end of 1950, or at the rate of about 16,000 barrels per well per day. There are also 29 shut-in wells and 15 observation wells. The producing wells are derived from an average 800-foot thickness of pay limestone. The API gravity of the oil from this field is 36.

The production of Iraq has come entirely from the Kirkuk field, although some heavy oil has been discovered in the Mosul area from shallow wells; i. e., less than 1000 feet. The API gravity of this crude is about 20. The new Basrah field will be in operation shortly when the pipe line is finished to Fao on the Persian Gulf.

Operations at the Kirkuk field are carried on entirely by the Iraq Petroleum Company which is owned by Anglo-Iranian, Compagnie Francaise des Petroles, Royal Dutch-Shell, Near East Development Cooperation (Standard Oil of New Jersey and Socony-Vacuum), each having 23.75 per cent interest and C. S. Gulbenkian who holds five per cent of the shares. This company was formed in 1928 and marks the first participation of American oil companies in Middle East operations.

Refining capacity in Iraq is small and most of the oil produced must be transported elsewhere. The only means of transportation is by pipeline. The first lines were built in 1934. These included two 12-inch lines from the Kirkuk field to the Mediterranean. One is 620 miles in length to the refinery owned jointly by Anglo-Iranian and Shell at Haifa, Palestine, and the other is 532 miles in length to Tripoli, Lebanon.

About four years ago, construction was begun on parallel 16-inch lines. The line to Tripoli was completed and, along with the older 12-inch line, is carrying its capacity of 160,000 barrels per day. The 16-inch line to Haifa has not yet been completed because of the Arab-Israeli conflict. When completion is allowed and the old 12-inch line to Haifa is again in operation, the total carrying capacity will be 150,000 barrels per day.

A 30-inch pipeline from Kirkuk to Banias, Syria, is now under construction which, along with other lines to Haifa

WORKERS DRAW A DRILL PIPE at Lali No. 1 well in Abadan.

and Tripoli, will bring transportation from Iraq to a potential of 610,000 barrels per day. Completion of this line is scheduled for July, 1952.

It is hoped that the Haifa, Palestine, refinery, jointly owned by Anglo-Iranian Oil Company and Shell Company, which has over 85,000 barrels a day capacity, will receive the Kirkuk crude which is now shut off by order of Iraq. Haifa's source of oil through the Suez Canal from the Persian Gulf has also been cut off. It is receiving about 20,000 barrels a day by tanker transportation around Africa and through the Mediterranean, or from Venezuela. At present it is receiving crude from Venezuela.

SAUDI ARABIA

The king of Saudi Arabia granted a concession to the Standard Oil of California in 1933, which was assigned to the Arabian American Oil Company in 1939. The company is owned by the Standard Oil of California, the Texas Company, and the Standard of New Jersey, each holding 30 per cent and 10 per cent by the Socony-Vacuum Oil Company. The concession covers an area of about 440,000 square miles, which is greater by 15,000 square miles than the state of Texas and California combined. Exploration and drilling were started in 1933. The results were most discouraging until 1936 when the Damman field was brought in. The daily production of Saudi Arabia at the end of 1950 was 618,000 barrels a day, which was stepped up during July of last year to an average of 820,000 barrels per day. Proved reserves have been estimated at nine and one-fifth billion barrels, but new fields are being discovered from time to time.

There are three oil-producing fields, with a total of 103 producing wells averaging about 6400 barrels per day per well. Their depths range from 4200 to 10,000 feet. The largest of these fields is in the Abqaiq, which is producing an average of about 500,000 barrels per day. The Ain Dar pool, discovered three years ago, is believed by some to be one of the largest fields ever found. Production has been averaging 129,000 barrels per day, but will be increased greatly in the near future. The oil pay thickness of Arabian wells ranges from 120 to 400 feet.

A new oil field was also discovered about two miles out in the Persian Gulf. This means a second new field this year, or a total of nine. The estimated proved area of the nine oil fields is approximately 300 square miles.

Aramco has a refinery located at Ras Tanura, which was built for military purposes in 1943-45. A substantial portion of the output of the refinery is for the United States Navy. It had a crude run of 157,000 barrels per calendar day for the first six months of 1951, and more recently has been operating at even higher capacities to offset particularly the loss at the Adaban refinery in Iran.

The population of Saudi Arabia is estimated to be six million, more or less, and domestic consumption of oil is small. The major part of the production and products is exported.

One of the greatest engineering feats of our time has been the Trans-Arabian pipeline which was completed in 1950 at a cost of about 230 million dollars. This 30-31-inch pipeline is 1068 miles long, and extends from the Persian Gulf through boiling desert to Sidon, Lebanon, on the Mediterranean. Entirely new ideas and tools had to be developed to cope with the unique conditions of sand, rock and heat. The desert fleet of trucks and cars consisted of more than 1500 units including giant 50-ton truck-tractors for hauling the pipe, trailers, refrigerator trucks and many other types of vehicles.

The capacity of the pipeline is over 300,000 barrels a day which could be increased by additional pumping equipment. This pipeline eliminates a 20-day, 7000-mile trip around the Arabian peninsula, through the Suez Canal, into the Mediterranean and return. It replaces 65 tankers and saves large sums in toll. The Suez Canal carries a toll of 18 cents a barrel—hence, a daily saving of $54,000 on that expense alone

KUWAIT

The tiny sheikdom of Kuwait, has an area of about 6000 square miles and only 100,000 or so inhabitants. The entire sheikdom is under lease to the Kuwait Oil Company, owned 50-50 by the Anglo-Iranian Oil Company and the Gulf Oil Company. A 75-year concession was granted in 1934.

The Burghan field, which is the only one producing at present, was discovered in 1938 at a depth of about 3700 feet. It was considered the largest single oil field ever discovered in the world. The Burghan field has estimated proved oil reserves of 15 billion barrels in about 90 square

miles. By comparison, the famous East Texas field is estimated to have had only five billion barrels at the outset.

Kuwait operations were almost discontinued in 1942 because of the war and actual commercial production did not begin until 1946. In July 1951, 650,000 barrels a day were produced from 94 wells, or an average of about 7000 barrels per well per day, with 16 wells kept in reserve. The crude is being produced from an oil sand over 1100 feet thick. Dr. G. M. Lees, chief geologist of the Anglo-Iranian Oil Company, stated: "The Burghan field of Kuwait, for example, has about 800 feet of effective sand distributed through 1100 feet of section—clean quartz sandstones of optimum degree of porosity and permeability. It would almost seem that a beneficent providence intended the region to be richly oil-bearing in a region which elsewhere has a dominant calcareous regime, suddenly sandstones appear, but sandstones of an excellence as reservoir rocks almost without parallel in oil field experience."

A 25,000-barrel-a-day refinery is now in operation in Kuwait to supply local needs and fuel for visiting tankers. Export at present is by tanker only, but a pipeline project has been under discussion to transport the oil from Kuwait on the Persian Gulf to the Mediterranean.

QATAR

The sheikdom of Qatar is a small peninsula of 4500 square miles, jutting out from Arabia into the Persian Gulf. The population is probably about 10,000. The Petroleum Development Company (Qatar), Ltd., composed of the same companies owning Iraq Petroleum Company, has a 75-year lease on the entire peninsula. By later agreement, all offshore territory within three miles is included. Offshore territory from three to twelve miles is included in a concession held jointly by the Superior Oil Company and the Central Mining and Investment Syndicate, a London firm.

Oil was discovered in the Dukhan field in 1939. Only two wells were drilled before the war and these were plugged until 1947. In 1950, production averaged 33,000 barrels daily and 1951 output is something less than 50,000 barrels per day—about 50 per cent more than in 1950.

BAHREIN

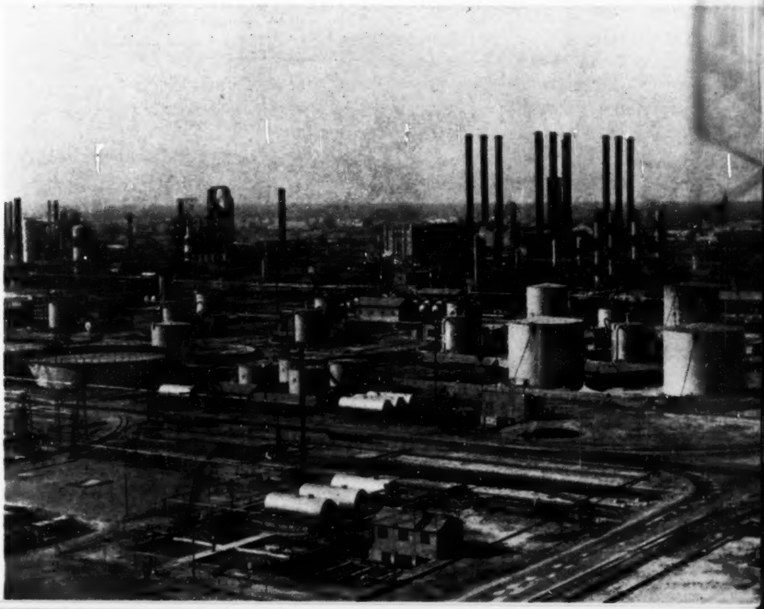
Bahrein is a small insular sheikdom about 210 square miles in area with a population of 120,000. This group of small islands is about 20 miles off the Saudi Arabia shore. A concession was granted to Bahrein Petroleum Company, owned by Standard Oil of California; the Texas Company later joined the Standard of California in the ownership of Bahrein in 1930. The original concession has been extended to cover the entire sheikdom until 1995. It was the first wholly American oil venture in the Middle East.

In 1932, the first well was brought in. The field now consists of 69 wells and production is slightly over 30,000 barrels per day or an average of some 440 barrels per day. Total production in 1950 was 11,015,711 barrels.

The Bahrein Island refinery is now one of the most important in the Middle East. Its capacity exceeds 175,000 barrels per day. It processes the entire Bahrein production and more than 145,000 barrels of crude which come from Saudi Arabia. Facilities include thermal and catalytic cracking units, aviation gasoline manufacturing units, an SO_2 p'ant, asphalt plant and others.

EXPORTS TO EUROPE

The largest market, for Middle Eastern oil, is Western Europe (outside of the Iron Curtain). Just before the Iranian crisis, 875,000 barrels of crude oil or about 44 per cent of the total production was being exported to Western European refineries. Of this total, 125,000 barrels of crude



ABADAN REFINERY, general view, shows distillation units on the left and the gas plant and power station on the right. The Shatt-al-Arab River is seen in the background.

came from Iran. Exports of refined products were at the rate of 175,000 barrels per day from the Middle East, 135,-000 of which come from Iran. These exports of crude oil and refined products accounted for about 90 per cent of the total West European demand. Increases in exports from countries other than Iran will be necessary not only to make up the deficit caused by loss of Iranian crude and refined products but also to meet growing West European demands. The rise in demand will be principally for crude oil to feed European refineries now being constructed. The vast refining expansion program will be discussed.

EUROPEAN REFINERIES

In Western Europe most of the refinery capacity was destroyed by bombing and after the war rehabilitation of old and construction of new refineries were needed to assist economic recovery. European nations wanted to be self-sufficient in regard to refined oil supplies, and the ECA was willing to assist in the refinery expansion program. It was believed that if European imports of refined products could be minimized and crude oil imported for refineries to manufacture such products for domestic consumption, the dollar shortage in Europe could be greatly lessened and a better trade balance established. Of th 235-million-dollar capital expenditures necessary for refinery expansion, the ECA has supplied 35 million dollars up to December 31, 1950. A major portion of the refinery expansion has been made by European subsidiaries of U. S. companies.

The Oil Committee of the Organization for European Economic Cooperation has kept close control over the European refinery expansion programs. It has required that all projects be submitted for approval before construction is begun and also that no construction be started within four months from the date of submission of estimates. It has also required that refinery programs be integrated to avoid duplication of refinery facilities, that expansion be restricted to take care of no more than indicated market demand and that no trade barriers be set up to obstruct free markets. It has also recommended that refinery design and construction employ American technical assistance, and consequently, most of the new European refineries are of American design. The Oil Committee has also recommended that European manufacturers be allowed to make as much refinery equipment as possible. Another requirement which has been insisted upon is that Europeon refiners do not start an octane race, with consequent increase in the cost of gasoline production.

A survey in the spring of 1950 showed that the octane rating of motor gasoline in most European countries was 70 to 72 motor method. In two or three countries a 65 motor method octane gasoline was still being marketed. A few countries, however, imported 74 to 76 motor method octane gasoline and some quantities of 78 to 80 octane premium gasoline.

A brief summary of European petroleum product demands and refinery production prewar, and in 1951 with estimated figures for the 1951-1953 fiscal year is given in Table I. The 1951 Western European demand for petroleum products is twice that of the prewar years.

TABLE I

EUROPEAN DEMAND AND REFINERY PRODUCTION

(Barrels per day)

	Prewar	1951	1952-3 (Fiscal)
Demand	520,000	1,125,000	1,220,000
Refinery Production	240,000	1,039,000	1,184,000

The refinery throughput and output of Western European countries is given by the OEEC in their second report on coordination of oil refinery expansion, dated August 1951. These data are given in Table II. The last three columns show the anticipated quantities through the fiscal year of 1952-3 as estimated in December 1950.

Refinery throughputs will have increased nearly five and one-half times over prewar by 1952-3. Table III gives the estimated throughput of Western European refineries in 1952-3 by countries.

Western European consumption of refined products, a prewar average, the actual consumption for 1948-49 and 1949-50 and the anticipated demand for three succeeding fiscal years are given in Table IV.

As a result of the modern refinery expansion program, the United Kingdom, France, Italy, Western Germany and Holland will soon be able to supply their domestic demands for refined products from their own refineries. In the United Kingdom, large refinery expansion projects are underway at Fawley, at Llandarcy in Wales, at Grangemouth in Scotland and in Kent. The Fawley refinery, the largest in Europe, is being constructed by the British subsidiary of the Standard Oil Company of New Jersey, and will shortly be in full operation. It operates on Middle East crudes and will require 126,000 barrels per day. The catalytic cracking plant has a capacity of 41,000 barrels a day. The lubricating oil capacity will be 4000 barrels a day. Two thermal reforming units will be used to improve the octane rating of straight-run gasoline.

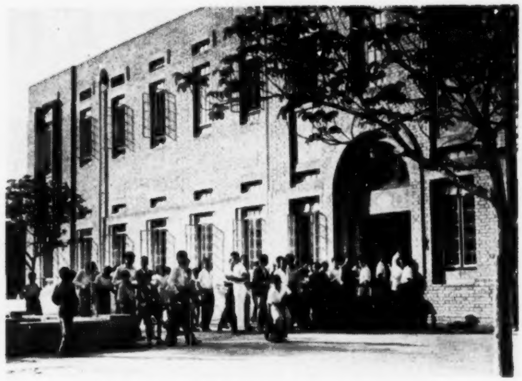
TABLE II

CRUDE OIL[1]

(Barrels per Day)

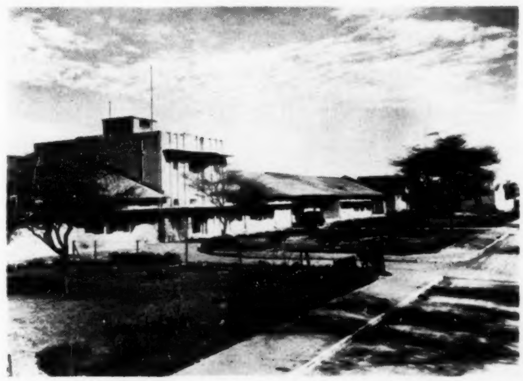
	PREWAR (Average)	1948-49	1949-50	1950-51	1951-52	1952-53
Refinery Output	224,000	418,000	624,000	936,000	1,149,000	1,302,000
Refinery Throughput	240,000	460,000	582,500	860,000	1,042,000	1,185,000

A GENERAL VIEW OF ABADAN, looking up-river, shows the Anglo-Iranian Oil Company's housing estate at Bawarda in the foreground with the old town immediately above. The refinery and other housing estates are seen beyond it.



A MODERN SCHOOL has been built for the children of Abadan.

AN INSIDE VIEW OF ABADAN



THE GENERAL HOSPITAL built by the Anglo-Persian Oil Company at Abadan has over 500 beds.

ABOUT 21,000 MODERN HOUSES have been built by the British at various centers for their Persian employees.

THIS GENERAL VIEW at Abadan shows the fire station, labor office, time office, tank farm and cracking plant.

TABLE III

1952-53 ESTIMATED THROUGHPUT[1]
OF EUROPEAN REFINERIES
(Barrels per Day)

Countries	
United Kingdom	426,000
France	339,000
Italy incl. Trieste	193,800
Benelux	162,000
Germany	127,000
Sweden	25,000
Portugal	6,400
Switzerland	2,000
Norway	800
Denmark	600
Total	1,303,400

In France 300,000 barrels a day of crude oil were refined in 1950, 27 per cent more than in 1949. For the year 1950-51, 360,000 barrels per day were processed. French refineries are now supplying all of the domestic demand for refined products with the exception of small amounts of specialties and are exporting to adjoining countries as well.

Germany's total refining capacity will be 127,000 barrels per day in 1952-3. The refineries include facilities for hydrogenating 30,000 barrels a day of residual fuel oil. By 1952, it is expected that present cracking capacity of 20,000 barrels a day will be increased by an equal amount in thermal cracking and 24,000 in catalytic cracking capacity. Germany has the largest lubricating oil capacity in Europe, 9200 barrels a day.

In Italy the refinery capacity is to be augmented by 40,700 barrels per day to reach a total of 193,800 barrels by mid-1953. At five different localities, new units are planned or

TABLE IV

TOTAL DOMESTIC CONSUMPTION OF FINISHED PRODUCTS[1]
(Barrels per Day)

	PREWAR (Average)	1948-49	1949-50	1950-51	1951-52	1952-53
Motor Gasoline	278,500	249,000	284,000	349,000	377,000	394,000
Kerosene	45,500	62,800	62,800	69,200	71,500	78,000
Gas/Diesel Oil	51,600	160,800	190,500	224,200	242,000	258,000
Fuel Oil	101,300	202,500	244,000	286,500	316,000	352,000
Lubricants	30,700	28,800	36,400	38,350	40,250	42,200
Miscellaneous Products	43,400	63,100	75,000	86,800	98,700	112,300
Total	551,000	767,000	892,700	1,054,050	1,145,450	1,236,500

under construction. The largest of these is at Milan, where the capacity will be 30,000 barrels a day.

The necessity of refining expansion to meet rising requirements for petroleum products is particularly well illustrated by data on lubricating oil imports and production. Demand for lubricating oils in European countries in 1950 was about 39,000 barrels a day. The imports of lubricating oils into Western European countries in 1949 and 1950 are given in Table V.

TABLE V

IMPORTS OF LUBRICATING OILS[2]
(Barrels per day)

	1949	1950
United Kingdom	5,650	8,400
France	1,248	1,180
Netherlands	1,323	1,710
Italy	1,440	1,840
Sweden	613	1,210
W. Germany	192	211
Belgium-Luxembourg	1,305	2,050
Denmark	518	748
Norway	633	594
Switzerland	441	748
Ireland	268	268
Portugal	249	192
Total	13,880	19,151

SUMMARY

While the refinery expansion program for Western Europe when completed, will decrease imports of refined products—the demand for crude will increase markedly. Although it is generally agreed that crude production in other Mid-Eastern countries can be increased sufficiently to offset the loss of Iranian crude, the shutdown of the Abadan refinery products is not so readily replaced. However, one can be certain that the oil industry will supply the products necessary to keep the economy of the democratic countries moving forward. The oil industry has always overcome the problems it has had to face, come peace or war.

The Middle East has the greatest reservoir of oil known in the world today. This oil resource must be protected as one of the most important factors in the security of Western civilization. The Western oil companies which have opened this miracle of wealth are entitled to a reasonable profit from their enormous investments in manpower and money. To continue doing so, they must have a sense of security in their investments, in the sanctity of contracts, to keep our moral world going.

[1]Data obtained from OEEC, 2nd Report in Coordination of Oil Refinery Expansion.

[2]Petroleum Press Service, Mar. 1951, p. 81.

THE FOUR-BALL

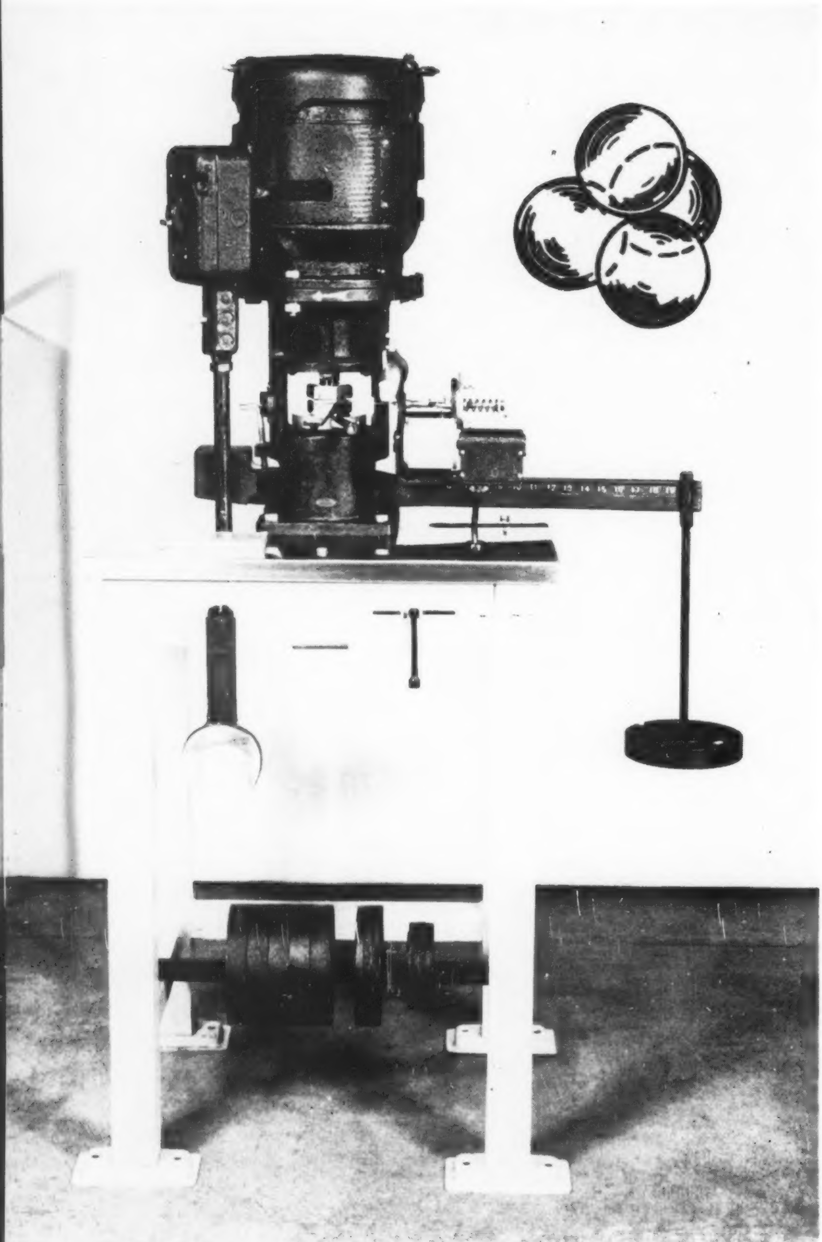


FIGURE 1

LEFT is shown the Shell Four-Ball Extreme Pressure Tester. The inset shows the geometry of the test balls.

E. P. TESTER

D. K. NASON
The Texas Company

This is a simplification of the Mean Hertz Load Test Procedure and is used in the industry as a test for screening the extreme pressure properties of grease as well as gear oils. Because of its current application to government specifications, it is felt this paper will be of general interest to SPOKESMAN readers.

THE object of the work carried out with the Shell Four-ball Extreme Pressure Tester, described in this article, is to investigate changes in the Navy procedure in order to shorten the time required to determine the Mean Hertz Load value of a lubricant without sacrificing the accuracy of the original Navy test.

The Four-Ball Machine is a device developed by the Royal Dutch Shell Corporation for determining the extreme pressure properties of lubricants[1]. The original model, devised for testing the extreme pressure and anti-weld properties of lubricants, has been used to develop the so-called "Mean Hertz Load" method of evaluating lubricants. This test procedure has now superseded the earlier Pressure Wear Index Method in Government specifications[2].

Insofar as the USNEES procedure is concerned, the Mean Hertz Load may be defined as the average of 20 successive corrected loads, with the actual loads having logarithmic (to the base ten) intervals of 0.05, and with the 21st load caus-

[1]Boerlage, G. D., Engineering, Vol. 13, July 14, 1933, p. 46.

[2]Procedure originated by U.S. Naval Engineering Experiment Station, Annapolis, Md. in cooperation with industry. Method now described in Federal Specification VV-L-791d, Amendment 1, Method 650.3 (June 20, 1950).

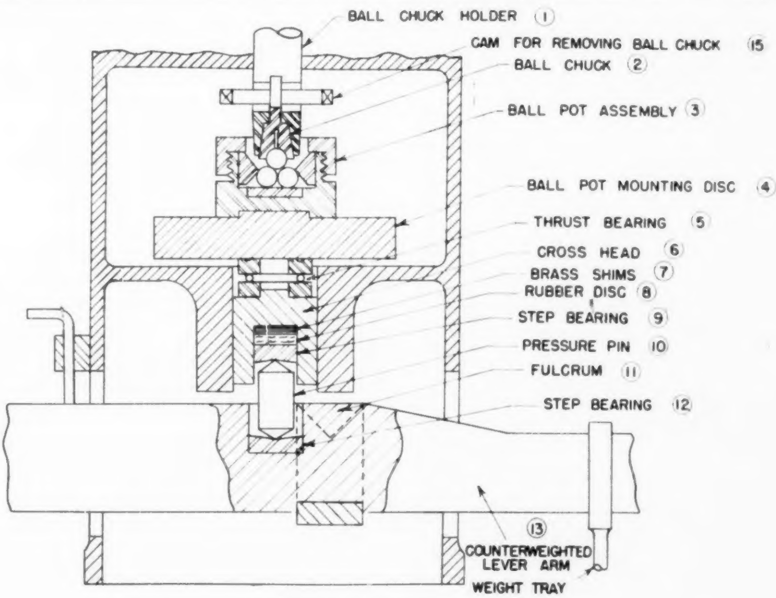


FIGURE 2

LEFT, THE FOUR-BALL E. P. TESTER is shown in use.

FIGURE 3

SAMPLE:
NAME
SAMPLE NO.:
BATCH NO.:
CHARGE NO.: REQ. BY
BALLS: GRADE, MFR
MACHINE OPERATOR
MEASURED BY
LOG SHEET NO.: DATE:
MIC. POWER:
MOTOR, RPM

Applied Load Kg.	M1		M2		M3		X Average Diameter mm.	LD_h Factor	Corrected Load $\frac{LD_h}{X}$
	1	2	3	4	5	6			
6								0.954	
7								1.120	
8								1.400	
9								1.638	
10								1.880	
11								2.134	
13								2.665	
14								2.940	
16								3.520	
18								4.122	
20								4.740	
22								5.390	
25								6.375	
28								7.420	
32								8.864	
36								10.37	
Base-40								11.96	
45								14.00	
50								16.10	
56								18.70	
63								21.86	
71								25.70	
79								29.62	
89								34.71	
100								40.50	
112								47.15	
126								55.19	
141								64.01	
158								74.58	
178								87.40	
200								102.2	
224								118.7	
251								138.3	
282								161.6	
316								188.0	
								TOTAL, A	
355								219.4	
398								255.5	
447								298.1	
501								347.2	
562								404.6	
631								472.6	
708								550.8	
794								641.6	
								AVERAGE, B	

Extreme Pressure Value = $\frac{A + B}{20}$

ing seizure of the steel test balls. The corrections applied to the loads are governed by the Hertz-line diameter and the average scar diameter at each load condition:

$$\text{Corrected load} = \text{Actual load} \times \frac{\text{Hertz-line diameter}}{\text{Actual diameter}}$$

The corrected load represents that part of the applied load which was instrumental in producing wear, while the difference between the actual and corrected loads represents the load which produced the initial elastic deformation of the test balls (Hertz deformation). The determination of actual Mean Hertz Loads is discussed in detail in the "Mean Hertz Load E.P. Test Procedure", Section B.

The increasing use of the Mean Hertz Load Test at The Texas Company's Beacon Laboratories has stimulated an investigation for abbreviating the test procedure without altering either the test equipment or the intent and precision of the procedure developed by the Navy.

The most tedious and time-consuming phase of the test procedure is reading the scar diameter by micrometer microscope twice (vertically and horizontally) on each of three steel-ball test specimens for each of 20 load conditions up to the weld point. As the six diameter readings for each load condition are averaged before corrected loads are calculated, it seemed possible that the vertical and horizontal scar diameters on one ball for each load condition might provide as reliable a corrected load as would the scar diameters of three balls. This possibility, and the possibility that ten instead of 20 load conditions could be used to determine Mean Hertz Loads satisfactorily, are investigated statistically in the following paragraphs.

For purposes of brevity, Mean Hertz Load will be referred to as M. H. L. throughout this article.

The work reported herein relates to the data for single M. H. L. runs of 28 oils and 14 greases, as well as to the and one grease. These lubricants are listed in Tables I, II and data for nine consecutive M. H. L. runs on each of three oils III.

Included in this report are statistical treatments of the following topics:

1. Precision of various abbreviated M. H. L. methods relative to the Navy method for M. H. L.
2. Extent of straight line correlation and agreement between the final modified methods for M. H. Loads and the Navy method for M. H. L.

EXPERIMENTAL WORK

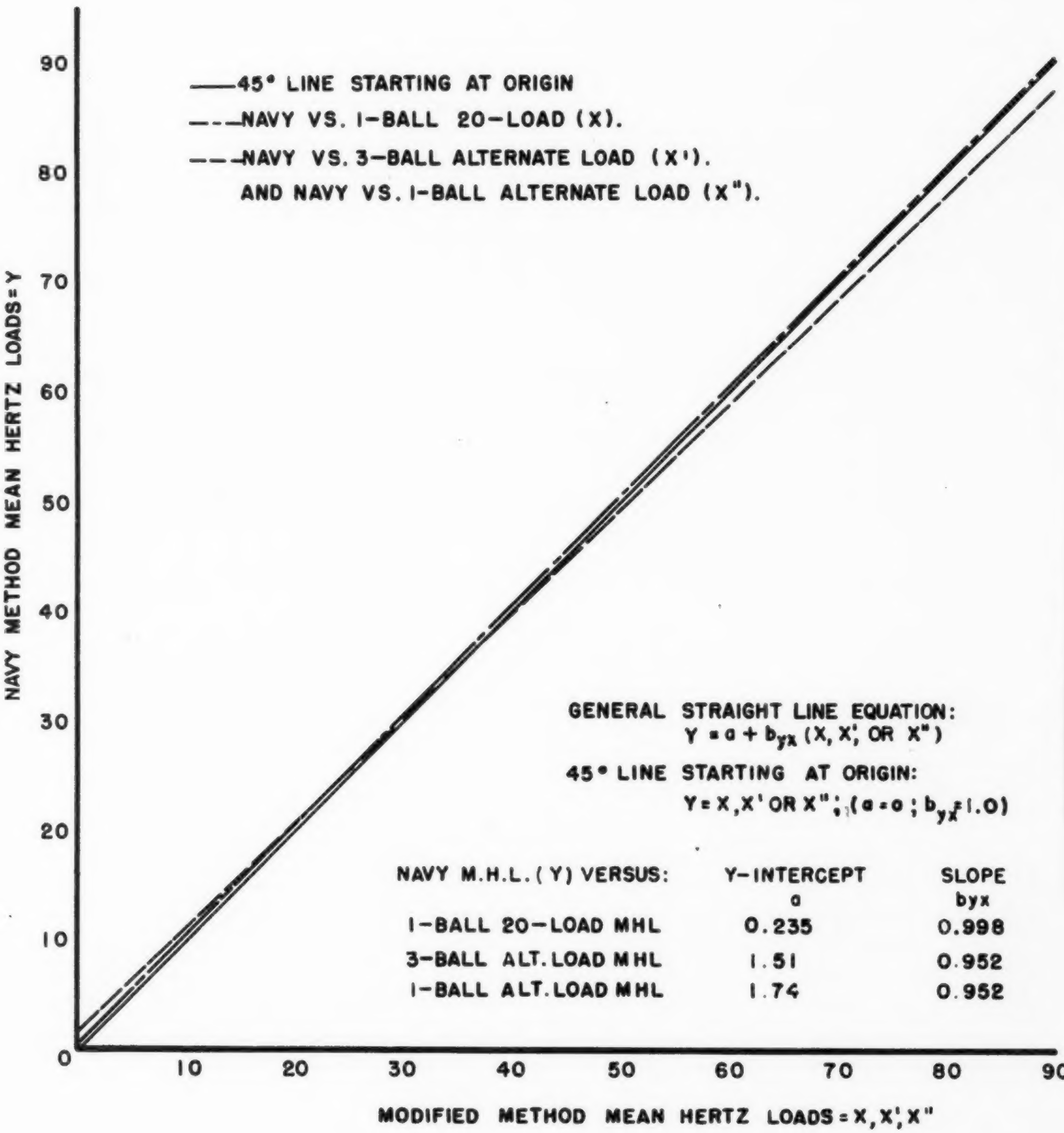
A. DESCRIPTION OF THE FOUR-BALL E. P. TESTER

The Four-Ball E. P. Tester, developed by the Royal Dutch Shell Corporation and constructed by the Precision Scientific Company, is pictured in Figure 1. Figure 2 shows a schematic diagram of the assembly of its essential parts.

Referring to Figure 2, the vertical driving shaft terminates in a ball-chuck holder (1), into which is inserted a ball-chuck (2), so constructed that it grasps the fourth ball more

FIGURE 4

PLOTS OF NAVY VS. CORRESPONDING MODIFIED METHOD MEAN HERTZ LOADS



EXAMPLE I

STUDENT'S t-TEST FOR SIGNIFICANT DIFFERENCE BETWEEN AVERAGES

$$t = \frac{\overline{Y} - \overline{X}}{\left[\frac{N_y + N_x}{N_y + N_x - 2}\right]^{1/2} \left[\frac{(N_y - 1)(\sigma p_y)^2 + (N_x - 1)(\sigma p_x)^2}{N_y \times N_x}\right]^{1/2}}$$

Where:

t = ratio between means to be compared with Student's range of t values to test for significance.

$\overline{X}$ = Arithmetic mean of modified method M. H. Loads.

$\overline{Y}$ = Arithmetic mean of corresponding Navy method M. H. Loads.

$N_y = N_x$ = Number of M. H. L. runs made (= 9).

$(\sigma p_x)^2$ = Variance of M. H. Loads calculated by modified method.

$(\sigma p_y)^2$ = Variance of corresponding M. H. Loads calculated by the Navy method.

NOTE: $(\sigma p)^2$ denotes variance calculated on basis of (N—1) runs in order to include any population of runs made in the future.

tightly as the load is increased. This fourth ball is rotated while pressed against the three lower balls, which are held stationary in the ball pot by means of the lock ring and nut. The test lubricant is contained in the ball pot. The ball-pot assembly (3), and mounting disc (4) are free to rotate about the vertical axis of the apparatus as they rest on a thrust bearing (5). A vertical load P, which acts through the cross-head (6), step bearing (9) and pressure pin (10) is applied to the ball pot by means of loading arm (13) and weight tray (14).

B. MEAN HERTZ LOAD E. P. TEST PROCEDURE

1. NAVY PROCEDURE[3]

Referring to Figure 2 the operational procedure is to insert three one-half-inch diameter Grade 1 SKF steel ball-bearing balls into the ball-pot assembly (3) and lock in place. The test lubricant is poured into the pot, covering the balls (in the case of greases, the balls are coated with the lubricant). A fourth ball is inserted in the ball-chuck (2) and is held there by action of the ball-chuck.

[3]Developed by USNEES, Annapolis, Md. See footnote 2.

TAB

THREE-BALL (Y), INDIVIDUAL ONE-BALL (X), ALTERNATE THREE

Average Mean Hertz Loads, Sigmas, Variation Coefficients

Each Lubricant

	Aircraft Engine Oil				E. P. Type Grease		
	Mean Hertz Loads				Mean Hertz Loads		
Run No.	Navy 3-Ball Y	1-Ball X	Alt. 3-Ball X′	Alt. 1-Ball X″	Navy 3-Ball Y	1-Ball X	Alt. 3-Ball X′
1	21.8	21.7	20.7	20.3	33.7	33.3	34.5
2	26.4	26.3	25.6	25.3	34.1	33.8	29.7
3	27.4	27.2	28.6	28.6	31.3	31.5	34.9
4	23.7	23.6	22.3	22.4	34.2	34.1	34.7
5	21.6	21.3	20.3	20.1	31.2	31.2	34.7
6	21.3	21.0	21.8	21.4	33.7	33.6	29.6
7	21.4	21.0	20.0	19.3	33.6	33.6	34.5
8	21.3	21.1	22.1	21.8	33.5	33.2	34.3
9	19.7	19.4	20.4	20.2	31.5	31.6	29.9
Avg. M. H. L.	22.7	22.5	22.4	22.2	33.0	32.9	33.0
(Sigma)^2 = Variance	6.68	6.99	8.27	8.98	1.58	1.25	5.95
Sigma = Std. deviation	2.58	2.64	2.88	3.00	1.26	1.12	2.44
Var. Coeff.	0.114	0.117	0.128	0.135	0.038	0.034	0.074
F-Ratio[1]	.....	1.05	1.24	1.34	....	1.26	3.76
t-Ratio[2]	....	0.179	0.241	0.432	....	0.179	0.00

[1]Values exceeding 6.03 denote significant difference in test precision relative to precision of Navy procedure at 99 per cent (3-sigr different populations is 1 out of 100.

[2]Values less than 2.921 denote no significant difference between $\overline{Y}$ and $\overline{X}$, (or $\overline{X}'$, or $\overline{X}''$) at 99 per cent (3-sigma) significance l

The ball-pot assembly is then centered under the fourth ball and the ball-pot mounting disc is inserted in its position. Load is applied in an upward direction by use of weights applied to the counterweighted lever arm. The motor operating at 1800 RPM under load is then started and permitted to run for ten seconds. The motor is then stopped and the three balls in the ball-pot assemly are removed for measurement of the scars formed by rubbing of the top or fourth ball on the lower three balls. The top ball is discarded without measurement.

With reference to the sample data sheet, Figure 3, a series of ten-second runs are made at the pre-selected loads shown in Column 1. These loads, rounded to the nearest kilogram, are separated from each other by equal logarithmic intervals. The first run is made with a load of 40 kg.[1] (marked Base) and subsequent runs at successively higher loads are made as prescribed by Column 1 until welding of the four balls occurs. Two check runs are made at the welding load. If welding does not occur in both of the check runs, a run is made at the next higher load, and two checks are made if welding occurs. If the verified welding load occurs at or below 316 kg., enough additional runs at the successively lower loads below 40 kg. are made to provide a total of 20 determinations.

The wear spots on the three lower balls from each run are measured horizontally and vertically on each ball with a micrometer microscope and are recorded as micrometer scale divisions in the appropriate data sheet columns subheaded 1 through 6 (see Figure 3). The six wear values for each load up to the weld point are totalled and multiplied by one-sixth and the factor for conversion of micrometer scale-divisions to millimeters to obtain the average diameter for the column so labeled.

The load corrected for elastic deformation of the test balls is obtained for each run by multiplying the actual load by the ratio of the wear-spot diameter on the Hertz line at that load to the measured wear-spot diameter:

$$\text{Corrected load} = \text{Actual load} \times \frac{\text{Hertz-line diameter}}{\text{Actual diameter}}$$

[1]40 kg. starting load selected because all lubricants appear to demonstrate their E. P. properties in the seizure zone. USNEES has seldom obtained seizure at smaller loads.

LE I

-BALL (X') AND ALTERNATE ONE-BALL (X") MEAN HERTZ LOADS

(Sigma/Avg. M. H. L.), F and t-Ratios for Four Lubricants Run Nine Times

	Industrial Gear Lubricant				Extreme Pressure Gear Lubricant			
	Mean Hertz Loads				Mean Hertz Loads			
Alt. 1-Ball X"	Navy 3-Ball Y	1-Ball X	Alt. 1-Ball X'	Alt. 3-Ball X"	Navy 3-Ball Y	1-Ball X	Alt. 1-Ball X'	Alt. 3-Ball X"
34.1	33.9	33.4	35.3	34.7	66.4	65.9	70.0	69.0
29.7	43.9	43.8	41.8	41.5	69.5	68.7	67.1	65.3
34.7	39.7	39.0	41.1	40.5	70.0	69.3	74.3	73.0
34.4	39.0	39.3	41.3	40.8	72.8	72.9	76.6	76.9
34.6	38.2	37.8	39.7	39.2	68.2	67.3	69.6	69.5
29.5	35.6	34.9	34.8	34.6	69.6	71.1	75.8	75.3
33.8	44.0	44.2	44.3	44.9	67.3	67.0	73.5	74.5
34.6	35.4	35.2	36.5	36.5	68.4	67.8	65.1	64.9
29.7	40.7	40.2	45.1	44.5	72.6	70.8	78.0	76.3
32.8	38.9	38.6	40.0	39.7	69.4	69.0	72.2	71.6
5.68	12.9	14.3	14.0	14.6	4.76	5.12	20.0	21.2
2.38	3.60	3.78	3.74	3.82	2.18	2.26	4.47	4.61
0.073	0.092	0.098	0.093	0.096	0.031	0.033	0.062	0.064
3.59	....	1.11	1.09	1.13	....	1.08	4.20	4.45
0.212	....	0.167	0.035	0.137	....	0.430	1.69	1.30

na) significance level. In other words, if F=6.03, the chances of the two populations of M. H. L. values being from statistically

evel.

As the actual load and the corresponding wear-spot diameter from the Hertz line are known in advance, their product is shown in the Factor LD_h column. The factor from this column for each test run, divided by the corresponding diameter from the Average Diameter column, gives the corrected load which is entered in the Corrected Load column.

The corrected loads from runs made at actual loads of 316 kg. or below are added and entered in the box marked Total A. If no runs have been made at loads higher than 316 kg., Total A is divided by 20 to obtain the M. H. L. (entered in the box at bottom of the data sheet) which is used as a criterion of extreme-pressure properties. If runs have been made at actual loads above 316 kg., the corrected loads (Column 10) from all such higher loads are averaged to represent the twentieth load. Average B added to Total A and divided by 20 gives the Mean Hertz Load value in this case.

TABLE II

OILS USED IN CORRELATION TEST BETWEEN NAVY AND MODIFIED MEAN HERTZ LOADS

	Mean Hertz Loads			
	20-Load Method		10-Load Method	
Oil Type	3-Ball	1-Ball	3-Ball	1-Ball
Gear Lube, E.P.	61.2	60.8	64.0	63.6
Gear Lube, E.P.	64.6	64.5	61.5	60.2
Gear Lube, E.P.	39.7	40.1	38.3	38.0
Light Mineral Oil	20.0	20.1	19.7	20.2
Light Mineral Oil + E.P.	25.4	24.7	25.2	24.2
Cutting Fluid, Grade B	51.2	51.4	52.7	53.0
Cutting Fluid, Grade B	59.8	59.7	61.2	61.3
Cutting Fluid, Grade B	58.8	59.0	59.7	59.8
Cutting Fluid, Grade B	41.9	42.2	42.9	43.8
Industrial Gear Lube	36.7	36.6	35.9	35.7
Industrial Gear Lube	44.0	43.5	46.8	46.1
Industrial Gear Lube	33.9	33.4	35.3	34.7
Aircraft Engine Oil	21.8	21.7	20.7	20.3
Gear Lube, E.P.	66.4	65.9	70.0	69.0
Diesel Lubricant, Used	34.5	34.1	35.5	34.7
Diesel Lubricant, Used	27.9	27.4	29.8	29.1
Gear Lube, E.P.	89.6	89.3	95.3	94.4
Soluble Oil + H_2O, 30:1 emulsion	23.5	23.2	24.5	24.4
Soluble Oil + H_2O, 10:1 emulsion	17.3	17.2	16.8	16.7
Soluble Oil + H_2O, 10:1 emulsion	19.3	19.3	20.1	20.1
Soluble Oil + H_2O, 30:1 emulsion	16.5	16.4	15.4	15.4
Diesel Lubricant	31.6	31.4	30.4	30.5
Pale Oil + E.P.	69.6	69.8	70.0	70.1
Diesel Lubricant	43.9	44.0	42.2	42.3
Pale Oil + E.P.	70.6	70.5	72.4	71.9
Pale Oil + E.P.	65.0	65.7	63.4	64.6
Pale Oil + E.P.	78.6	77.9	83.5	82.8
Pale Oil + E.P.	77.1	77.0	80.6	81.4
Gear Lube, E.P.	52.7	52.2	51.9	51.3

2. MODIFICATION OF THE NAVY FOUR-BALL E. P. PROCEDURE

Because of the ever-present desire to increase test output with no sacrifice of quality, a method for reducing test time without changing the intent of the Navy procedure or sacrificing test precision was sought. Accordingly, elimination of time-consuming scar diameter readings for two out of three balls for each of the 20 load conditions was investigated. In addition to this, "alternate load" M. H. Loads were calculated by both the one-ball and the three-ball methods and compared to the corresponding three-ball M. H. Loads. The "alternate load" M. H. Loads were calculated by using every other one-ball or three-ball corrected load corresponding with applied loads 40, 50, 63, 79, etc. kilograms.

A modified formula was used for calculating alternate load M. H. Loads:

$$\text{M. H. L.} = \frac{\text{Total A} + \frac{\text{Average B}}{2}}{10} \quad \text{(See Figure 3)}$$

The Average B (average of corrected loads corresponding to applied loads of 355 kg. or above) is divided by two to compensate for the fact that Total A for the alternate load is approximately half of the Total A for the one-ball or three-ball 20-load methods. The denominator is 10 because 10 instead of 20 corrected loads are utilized in the M. H. L. determination.

The one-ball 20-load method and the one- and three-ball alternate load methods described above would all consume considerably less time than the original Navy method for M. H. L. determination. The precision, correlatability and agreement of the three modified methods versus the Navy method were determined as the next step, and will be discussed in the following sections. Pertinent statistical methods were used to ascertain these ratings.

C. RESULTS AND DISCUSSION

Three oils and one grease were run nine times each so that their one-ball 20-load, and one- and three-ball alternate load M. H. Loads could be compared statistically against the corresponding Navy-method M. H. Loads for reproducibility, precision, and the differences between the averages.

Also, coefficients of determination for the M. H. Loads of 42 lubricants picked at random from data on hand were calculated to show the extent of straight-line direct correlation between M. H. Loads determined by the abbreviated methods and the Navy-method M. H. Loads, and the linear agreement has been plotted for the methods in question.

1. REPRODUCIBILITY AND PRECISION OF NAVY AND MODIFIED PROCEDURE M. H. LOADS (VARIATION COERRICIENTS AND F-TEST)

As may be seen from Table I, the four lubricants are representative of types commonly tested on the Four-Ball

TABLE III

GREASES USED IN CORRELATION TEST BETWEEN NAVY AND MODIFIED MEAN HERTZ LOADS

		Mean Hertz Loads			
		20-Load Method		10-Load Method	
Grease Type	Soap Base	3-Ball	1-Ball	3-Ball	1-Ball
Low Temperature EP	Lithium	43.8	43.4	42.9	42.3
Low Temperature	Lithium	20.7	20.5	21.7	21.5
Low Temperature	Lithium	16.3	16.2	16.1	15.6
E.P. Grease	Sodium-Lead	40.9	40.1	43.2	42.1
Low Temperature	Lithium	29.0	29.4	28.6	28.6
Low Temperature	Lithium	33.9	33.4	33.0	32.5
Low Temperature EP	Lithium	55.7	56.9	56.5	57.4
Low Temperature	Lithium	29.8	29.6	29.7	29.5
Wheel Bearing	Sodium	27.0	26.8	25.5	25.2
Chassis	Sodium	27.3	27.0	28.3	27.7
General Purpose Aircraft EP	Sodium-Calcium	41.7	41.3	43.7	43.0
General Purpose Aircraft EP	Sodium-Calcium	48.6	48.3	47.4	46.8
General Purpose Aircraft EP	Sodium-Calcium	47.7	47.9	46.2	46.8
Low Temperature	Lithium	17.5	17.2	18.6	18.5

E. P. Tester, and have M. H. Loads ranging from 22 to 70. The coefficients of variation (sigma/avg. M. H. L.) given on Table I are measures of the dispersion of the M. H. L. values relative to the M. H. L. values themselves.

It is not considered satisfactory from a statistical standpoint, however, to make a visual study of the calculated variation coefficients and predict whether or not the smaller variation of a group under investigation shows any actual difference in precision. Rather, it is necessary to apply some statistical test to the variation in order to determine whether the groups of results are significantly different or not. In this analysis the F-Test[5] was used to determine significance.

The F-ratio for comparing the precisions, for example, of the 20-load three-ball and one-ball M. H. Loads for the aircraft engine oil is the quotient of the larger variance (sigma squared) divided by the smaller variance. This quotient is then compared to a dimensionless number obtained from an F-Table[6], the exact value being governed by the number of runs in each distribution (9 in our case), and the result is analyzed as follows:

If the calculated F-ratio falls below the value found in the table (6.03 in this case, at the 99 per cent statistical level), there is no significant difference between the two sets of M. H. L. values under investigation.

Table I reveals that none of the F-ratios equal or exceed 6.03. It follows, then, that all three of the suggested modified M. H. L. methods are as precise as the Navy method M. H. Loads at the 99 per cent significance level for the four lubricants compared.

[5]Statistical Methods, George Snedecor, Iowa State Collegiate Press, 1940 edition.

[6]F-Tables, five per cent to one per cent level, Statistical Methods, George Snedecor, Iowa State Collegiate Press, pages 184-187, inclusive (1940 edition).

2. DIFFERENCE BETWEEN AVERAGE NAVY METHOD M. H. LOADS AND CORRESPONDING AVERAGE MODIFIED METHOD M. H. LOADS (t-TEST)

The t-ratio[*], which was used to indicate whether there was a significant difference between average Navy method M. H. Loads and corresponding average modified method M. H. Loads, was determined according to the formula given in Example 1.

In order that there be no significant difference between means at the 99 per cent significance level, the calculated value should be less than 2.921[*]. Table I shows that none of the t-ratios approach 2.921. Hence, there is no significant difference on the 99 per cent level between any of the average modified method M. H. Loads and the corresponding Navy method M. H. Loads for the four lubricants tested, in spite of the fact that the alternate-load variation coefficients for the grease and E. P. Gear Lubricant considerably exceed the corresponding 20-load variation coefficients.

3. EXTENT OF DIRECT CORRELATION AND AGREEMENT BETWEEN MODIFIED METHOD M. H. LOADS AND CORRESPONDING NAVY METHOD M. H. LOADS

Modified and Navy M. H. Loads were calculated for 14 greases and 28 oils of various types (See Tables II and III) from data picked at random[7], in order that the extent of direct correlation and agreement between modified and Navy M. H. Loads could be calculated statistically. The statistical treatments will be discussed in the following sections.

[*]Modern Statistical Methods, P. Rider, John Wiley & Sons, Inc., 1939.

[7]The 42 lubricants have M. H. Loads ranging from 15 to 90.

a. COEFFICIENTS OF DETERMINATION

As a verification of the apparent (Table I) close corresponding M. H. Loads calculated by any one of the three suggested modified methods, coefficients of determination (r_{xy}^2) were calculated[8]. The coefficient of determination shows what proportion of the variance in the values of the dependent variable (Navy three-ball M. H. Loads can be explained by, or estimated from, the concomitant variation in the values of the independent variable (abbreviated mthod M. H. Loads).

A coefficient of 1.0 indicates perfect direct correlation[9]. The actual coefficients obtained are all in the vicinity of 0.98 and 0.99, which shows that the degree of correlation between the modified M. H. Loads and the Navy three-ball M. H. Loads is very high as shown in the following tabulation:

Navy M. H. Loads Versus Corresponding:	Coefficient of Determination, r_{xy}^2
1-Ball M. H. Loads	0.985
3-Ball Alternate Load M. H. Loads	0.979
1-Ball Alternate Load M. H. Loads	0.990

[8]Calculations made according to the methods shown in M. Ezekiel's "Methods of Correlation Analysis", John Wiley and Sons (1930), pages 125-130, inclusive.

[9]Perfect inverse correlation is denoted by determination coefficient of —1.0.

b. AGREEMENT

It should be pointed out that the term correlation implies a recognizable relationship between the corresponding changes of two variables, such as that shown to exist between Navy M. H. L. and a Modified Method M. H. L. The numerical values and units in which these related variables are expressed need not be identical to fulfill the definition of perfect correlation. Perfect *agreement* between variables, on the other hand, indicates that the units of both variables are identical and that the numerical values of both remain identical despite change.

The coefficients of determination discussed under section "a" indicate nearly perfect direct correlation between the modified method M. H. Loads and the corresponding Navy Method M. H. Loads. It is of further interest to determine the extent of agreement between modified method M. H. Loads and Navy-method M. H. Loads for the 42 lubricants. Perfect agreement would be attained between Navy and Modified M. H. Loads if a rectangular plot of modified versus corresponding Navy M. H. Loads yields a 45-degree (slope = 1.0) straight line starting at the origin, and if the coefficient of determination is equal to 1.0.

Figure 4 shows plots of the various modified M. H. Loads on the horizontal axis versus Navy M. H. Loads on the vertical axis[10]. These plots all lie very close to the solid 45-

[10]These plots were determined by statistical methods described in Ezekiel's "Methods of Correlation Analysis", ibid.

degree line, which shows that the agreement between modified and corresponding Navy M. H. Loads is very good.

More specifically, the constants (a) and slopes (b_{yx}) for the straight-line plots of the modified method M. H. Loads versus the corresponding Navy method M. H. Loads show:

a. That one-ball 20-load and corresponding Navy M. H. Loads are, for all practical purposes, equivalent.

b. That one- and three-ball alternate load M. H. Loads are numerically equivalent to the nearest digit when read from the graph (Figure 4).

c. That in general modified method M. H. Loads are in close agreement with Navy method M. H. Loads.

4. INCREASE IN WORK OUTPUT WHEN ONE-BALL 20- LOAD OR ALTERNATE LOAD METHOD IS USED

A single Four-Ball-Machine operator at Beacon Laboratories is able to turn out four complete M. H. L. determinations by the one-ball method in one eight-hour day, as against two determinations in the same amount of time by the three-ball method. Therefore, the one-ball method is noteworthy both from an economic and from a time-saving point of view.

The alternate load methods further reduce test time and consumption of test balls per lubricant. It is anticipated that a one-ball alternate load M. H. L. test would take about one-third the time for a Navy three-ball test.

CONCLUSIONS

Basis the data and statistical treatments presented herein, the following conclusions are drawn:

1. Scar diameter measurement of one ball-test specimen per load condition appears to sacrifice none of the precision of M. H. L. values achieved when the scars of three test balls are measured at each load.
2. The one- and three-ball alternate load (ten-load) test methods give M. H. L. values which are not significantly different in precision from the Navy M. H. L. values.
3. Average M. H. L. values determined by the modified methods are not significantly different from the corresponding average Navy-method M. H. L.
4. From a statistical standpoint, the degrees of direct linear correlation and agreement between the Navy and the three Modified M. H. Loads are very high, with the one-ball 20-load method showing slightly better agreement with the Navy M. H. Loads than do the alternate-load methods.
5. The modified M. H. L. determinations reduce test time considerably as compared with the present M. H. L. Method. The alternate-load methods cut consumption of test balls in half.

ACKNOWLEDGEMENTS

The author is grateful to Mr. F. H. Herdt for suggesting the modifications in Mean Hertz Load test procedure evaluated above and for helping with the calculations involved. Thanks also are expressed to Messrs. R. S. Barnett, J. Sherman, and R. F. Strohecker for their constructive comments on the write-up.

The Technical Committee

Chairman T. G. Roehner, Director of the Technical Service Department, Socony-Vacuum Laboratories

The A B E C- N L G I Cooperative Committee on Grease Test Methods held a one-day meeting at the offices of the Anti-Friction Bearing Manufacturers Association, in New York City, on January 22. It was agreed that hereafter this group will be known as the A F B M A-N L G I Cooperative Committee, in recognition of the fact that in addition to A B E C (Annular Bearing Engineers' Committee) the R B E C (Roller Bearing Engineers' Committee) is also interested. The subjects discussed were the B E C Grease Testing Machine, High Pressure Greasing Equipment, Friction Oxidation or Fretting Corrosion Testers, Lubricity of Greases, Compatibility of Greases, Water Washout and Rust Preventive Properties, and Wheel Bearing Lubrication.

The B E C Grease Testing Machine has been under study by this group as a screening tester. It is not designed for long-time tests but it is capable of obtaining indicative information within a few hours regarding the behavior of lubricating greases in the ball bearings. The equipment has an oil bath which can be heated to allow test temperatures up to 250°F. and higher. It also has a device for measuring running torque. Data may be obtained on leakage and changes in structure, but it obviously is not designed for evaluating lubricating greases in terms of chemical stability. The meeting agreed that the only change in procedure for operating the B E C Machine, indicated as desirable by experience since the previous meeting, was the reduction in amount of grease from 3 to 1.5 grams, in order to avoid over-packing the test bearing. Work on the design of the machine is regarded as completed. A method covering the unit has been turned over to Section III, on Functional Tests for Lubricating Greases Employing Antifriction Bearings, of A S T M Technical Committee G, for their consideration as a subject for standardization.

The subcommittee on preparation of a bulletin on precautions to be observed to prevent rupture of seals of antifriction bearings when lubricated with high pressure lubricating grease equipment reported that they are still assembling information from manufacturers of bearings, dispensing equipment, relief pressure fittings, bearing seals and lubricating greases. The subcommittee met on February 6 to study the information on hand and decide on the next steps.

A new design of the Fafnir Friction Oxidation Testing Machine was described and an offer was made to provide prints on request to companies interested in building the tester for their own use. It is reported to have corrected the disadvantages of the old Fafnir machine and to provide good reproducibility. In the committee discussions, the terms "friction oxidation" and "fretting corrosion" were used interchangeably.

The remainder of the items involving evaluations of lubricating greases for the properties noted above were discussed sufficiently to enable an exchange of ideas regarding definitions and proposals for possible investigation. In all cases, the committee decided to either set up subcommittees to further study the proposal or to await action by other groups known to have already initiated investigations.

The preceding is only a brief outline of the discussions. If further information is desired, refer your questions to the undersigned.

The Joint Committee on Lubricating Greases for Railroad Antifriction Journal Bearings met on January 23, also at the headquarters of the Anti-Friction Bearing Manufacturers Association. It will be recalled that this is a cooperative activity between the American Association of Railroads, Anti-Friction Bearing Manufacturers Association, and the National Lubricating Grease Institute. At this meeting they discussed test methods of the following types:

1—Laboratory Chemical and Physical Tests
- (a) For Qualification
- (b) For Quality Control

2—Performance Tests
- (a) Laboratory Functional Tests
- (b) Service Tests

It was agreed that chemical and physical tests would be used to screen products to be evaluated by either or both of the performance tests. If both types of performance tests were run, the laboratory functional tests would be regarded as the secondary screening preparatory for the final evaluation, namely, use in the field under actual service conditions.

As mentioned in a previous issue of this column, the committee has had under consideration tests for sixteen properties. Of these, only Ash Content was completely eliminated from further consideration at this meeting. Determination of

(*continued on page* 36)

N L G I RECOGNITION

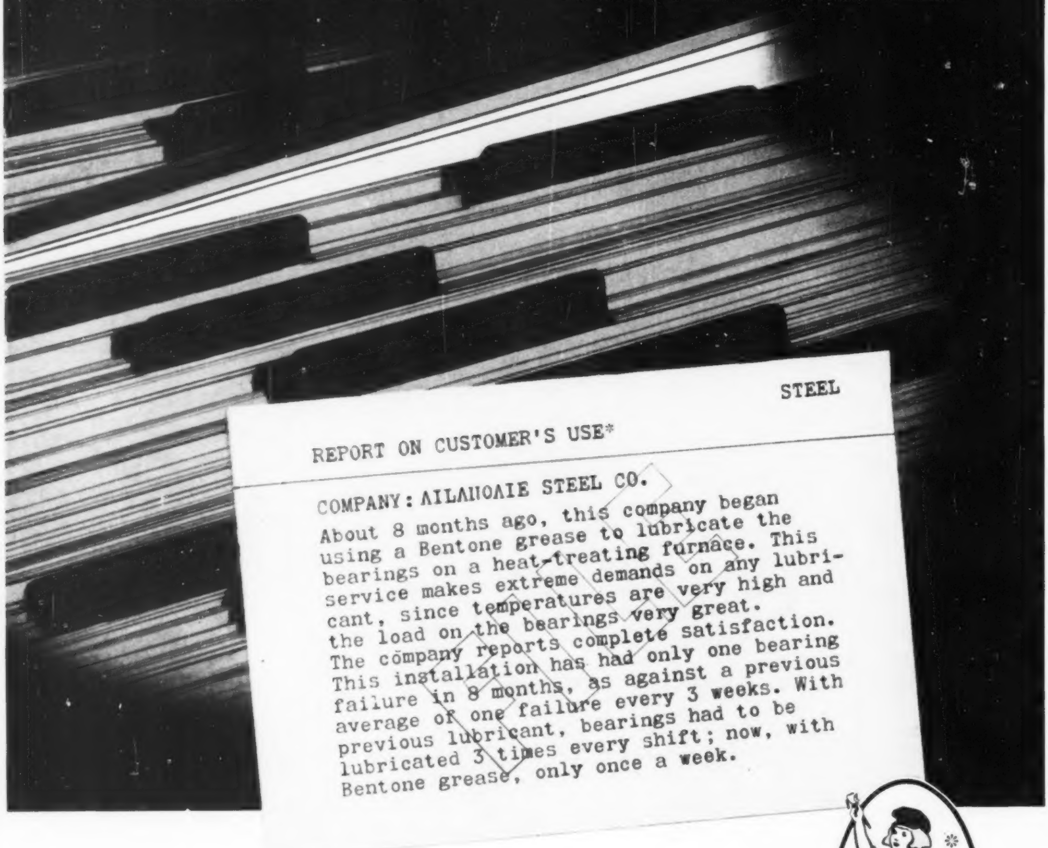
The United States Department of Commerce has just notified the N L G I that it has been selected as one of twenty some associations whose contribution to the war effort will be described and widely circulated.

Emphasized in their description of our activities is the cooperative work done with other groups. These include the American Society for Testing Materials, Association of American Railroads, Anti-Friction Bearing Manufacturers' Association, American Petroleum Institute, Dispensing Equipment Manufacturers and others.

Preliminary reports indicate the departments considerable interest in our inter-industry work on a cooperative basis.

EVERY INDUSTRY SAYS THE SAME THING...

"Bentone greases far superior to anything else we have used"



In industry after industry, greases prepared with "Dutch Boy" Bentone 34 are making extraordinary records under conditions of extreme pressures and extremes of temperature. Bentone greases "stay put" when no other lubricant will, and are superior in stability and water resistance. For information on greases prepared with

*Courtesy Warren Refining and Chemical Co.

Dutch Boy*

TRADE MARKS REGISTERED U. S. PATENT OFFICE

BENTONE ★ 34

a radically new, non-soap gelling agent

write to.......

NATIONAL LEAD COMPANY
BAROID SALES DIVISION
1376 River Avenue • Pittsburgh 12, Penna.

Patents and Developments

GREASES CONTAINING CYCLOALKANOATES

New greases have been mentioned in this column, possessing "superior" structural stability especially at high temperatures, and prepared by combining with the conventional soaps, certain low molecular weight materials. For example, U. S. Patent 2,516,136 suggested certain heterocyclic acid salts, such as lithium furoate, for this purpose.

In its U. S. Patent 2,576,032, Standard Oil Development Co., proposes the use of low molecular weight cycloaliphatic and substituted alicyclic carboxylic acids as the low molecular weight constituent of such soap-salt type greases. The acid radical of such a salt should have a molecular weight of not over about 160, and preferred examples of acids are given as cyclopropanoic, cyclobutanoic and cyclopentanoic acids. Hexathydrobenzoic acid also may be used, although it approaches the maximum limit of molecular weight. For convenience, the metal radical preferably is the same as that of the soap.

Best results are obtained by combining 1-2 mols of low molecular weight salt (based on the acid radical) with about 1-4 mols of the soap, so that the preferred weight ratio in the finished product falls in the range of 1-2 to 1-4.

An example of a composition prepared in accordance with the invention is as follows:

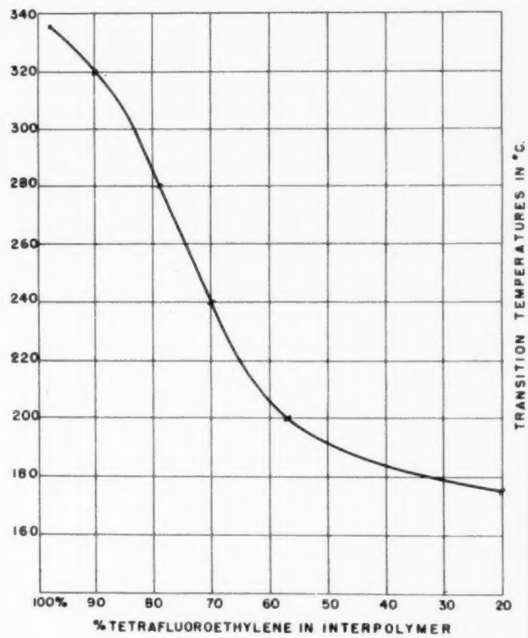
INGREDIENTS	PER CENT BY WEIGHT
Cyclopentane Carboxylic Acid (Cyclopentanoic Acid)	6.0
Hydrogenated Fish Oil Acids of C_{14} to C_{18} Predominantly (Hydrofol Acids 54)	15.0
NaOH	4.4
Phenyl a-naphthylamine	1.0
Mineral Lubricating Oil (Coastal Base 55 SUS Viscosity at 210° F.)	73.6
Per Cent Free Alkalinity as NaOH	0.25
Dropping Point, °F.	384
Water Washing Test, 125° F.:	
Water Temperature, Per Cent Loss	5.0
ASTM Penetration mm./10:	
60 Strokes	220
100,000 Strokes	310
Wheel Bearing Test, 6 Hours at 220° F.	Pass

FLUOROPOLYMER GREASES

Fluorocarbon oils, such as those described in Industrial & Engineering Chemistry, March 1947, pp. 290-354, are completely fluorinated hydrocarbons containing no residual unsubstituted hydrogen. Such compounds are claimed to be valuable as lubricants because they are stable at elevated temperatures and inert to most chemicals. Unfortunately they thin out rapidly at higher temperatures.

In its U. S. Patent 2,576,837, Du Pont describes how this latter property may be overcome by use of viscosity index-improving fluoropolymers, particularly by an interpolymer of tetra-fluoroethylene with chlorotrifluoroethylene, such as that described in U. S. Patent 2,393,967.

FIGURE I



In order to obtain satisfactory products, a mixture of the fluorocarbon oil and interpolymer, in the desired proportions, is heated to 175° C.-400° C. and to at least the transition temperature, continuing the heating until the mixture is converted to a clear and homogeneous mass and its viscosity increases noticeably. Then the mixture is cooled and mulled, if desired. The minimum transition temperature varies with the interpolymer composition in accordance with the curve shown in Figure 1. The exact transition temperature in any case can be determined by heating slowly the mixture of fluorocarbon oil and selected interpolymer, in powder form, with stirring, whereupon the mixture will become progressively thinner with increase in temperature until suddenly, when the transition temperature is reached, the mixture becomes clear, homogeneous, and more viscous. Interpolymers containing 34 per cent or more of tetrafluoroethylene are preferred because of their higher transition temperatures which render the products useful at higher temperatures. A particularly desirable interpolymer is one containing 57 per cent to 90 per cent tetrafluoroethylene.

In one example, 4 gm. of an interpolymer (57 per cent tetrafluoroethylene, 43 per cent chlorotrifluoroethylene) in the form of a dry powder, was heated with 36 gm. of fluorocarbon oil (distillation range 150°C.-170°C./10 mm.) the heating being done with constant stirring. As the temperature was increased, the slurry became thinner until, at about 200°C., the entire mass suddenly became viscous and homogeneous. Upon cooling and milling, an excellent grease resulted which was very resistant to chlorine, wet HCl, and caustic, and was of very great value as a lubricant for corrosive locations. It was practically insoluble in most organic solvents such as CCl_4, acetone, perchloroethylene and o-dichlorobenzene. It had penetration (ASTM) values of 270 at 77°F. and 355 at 210°F., compared to 210 and 305 for a comparable commercial calcium base grease.

HIGH MELTING—HIGH WATER RESISTANT GREASE

It is known that soda soap greases have good high temperature characteristics, but very poor resistance to water. Lime soap greases have good resistance to water, but have very low softening temperatures. Blending together a soda grease and a lime grease does not satisfactorily obtain the high melting effect of a soda grease and the high water resistance of the lime grease. The ratio of lime soap to soda soap required to obtain water resistance is so high that the melting point of the mixed grease is greatly reduced. Lithium greases have shown an improvement in this direction, but they are usually too expensive for many uses.

In its U. S. Patent 2,577,706, California Research Corporation discloses production of a grease satisfactorily meeting the requirements, by use of a partially saponified polymeric compound. A high melting point, highly water-resistant grease is obtained by incorporating in the lubricating oil as a thickening agent, a metal salt of an organic acid, and a polymeric compound containing recurring saponifiable polar groups, some of which are saponified. Examples of the latter are partial potassium salts of poly octyl methacrylate or cetyl methacrylate copolymer, partial lithium salts of polyauryl methacrylate or polypentaerithrityl polyglyceryl soyate pyromellitate, partial sodium salts of cetyl methacrylate copolymer, and partial barium or calcium salts of cetyl methacrylate copolymers.

It is preferred that the high melting point grease having a partially saponified polymeric compound incorporated therein be a soda base grease, i. e., employ a sodium soap as the thickening agent, due to the exceptionally high melting point of the latter. When the partially saponified polymeric compound is added in sufficient amount to it, the resultant grease has not only the desirable high temperature qualities of a typical soda base grease, but also substantial resistance even to boiling water.

In one example given, 10 gm. of a polyoctyl methacrylate (molecular weight 10,000) in a 55 per cent petroleum oil solution, 0.5 gm. potassium hydroxide, and 10 gm. of a mineral oil of 464 SSU at 100°F. were mixed together and heated at 400°F. for 1 hr. and then cooled to room temperature. The resulting potassium polyoctyl methacrylate concentrate was thoroughly milled into a mineral oil grease containing 14 per cent sodium stearate. The final grease contained 10 per cent of the partially saponified polymer concentrate.

NEWS ITEMS

British-American Oil Co. will build a one-and-one-half-million-dollar grease plant at Clarkston, Ontario, with capacity of 15 million lb/yr. (Petroleum Proc. Highlights 12/28/51 p. 2)

The Naval Engineering Experiment Station at Annapolis developed an electronic motor grease tester for large, slow-speed bearings. (Prod. Engrg. 12/51 p. 182)

Bearings, lubricants, and lubrication-digest of 1950 literature (Mech. Engrg. 11/51 p. 892).

American Cyanamid Co. issued its booklet on its aluminum stearates for lubricating greases. Gel stability is improved greatly by replacement of a small part of the stearate acid with dimer acid (dimerized linoleic acid).

Mechanical break-down of soap-base greases (due to breakage of soap fibers during work softening) — Moore, et al. (Indus. & Engrg. Chem. 12/51 p. 2892).

Automotive gear lubricants and greases — charts normal pattern of fatigue failures for anti-friction bearings in terms of mileage—Stokely, et al., (Soc. Auto. Engrs. 11/51 p. 79).

The Technical Committee . . .

(Continued from page 33)

Compatibility, Water Wash Out Resistance, Rust Preventive Properties, and Aeration were removed from the list of Chemical and Physical Tests, but they were retained as properties to be studied as part of the information to be obtained from performance tests. The remainder, namely, Freedom from Dirt or Abrasive Material, Soap Content, Viscosity of Mineral Oil, A S T M Penetration, A S T M Dropping Point, Oxidation Resistance, Copper Corrosion, Consistency-Temperature Relationships, Oil Separation in Packages or Stored Bearings will hereafter compose the list of Chemical and Physical Tests and will be used either as quality control or qualification tests, or both. A S T M methods were adopted whenever available. When an A S T M Method was not in the D-2 book, study groups were organized to review other published methods and report their recommendations to the committee.

There was considerable discussion of both of the aforementioned types of performance tests. It was not apparent that any one of the published laboratory functional tests would satisfy the particular requirements for this application. Therefore, a study group was formed under the chairmanship of Mr. Rockwell to obtain data on such testers and return to the committee with a recommendation. The service tests will be conducted in bearings in both passenger and freight cars on the road. A tentative procedure was outlined for those tests so that they would be conducted under sufficiently similar conditions to yield data that could be regarded on a common basis.

The only change in membership of this joint committee is the addition of Mr. E. M. Higgins, of Master Lubricants Company, as a representative of the N L G I Technical Committee.

SUPPLIERS OF MATERIALS FOR MANUFACTURING LUBRICATING GREASES

HELP WANTED

THE PLANT is located at Auburn, Indiana, which is also the home of the main office.

1921 1952

RIEKE METAL PRODUCTS CORPORATION

Closure Manufacturer Welcomed Into N L G I Membership

Thirty-one years ago, T. W. Rieke is said to have developed the first mechanically-inserted drum closure and founded the Rieke Metal Products Corporation in Chicago. Prior to this, all closures were hand-welded into the drum heads. Welding was a slow and costly method. Tightness and strength of the closure depended on the skill of the welder.

In 1923, the corporation was moved to Auburn, Indiana, where the main office and plant are located today. Glenn T. Rieke is president and Irvin H. Rieke is chairman of the board of directors. Both are sons of T. W. Rieke. Sales offices are in New York, Cleveland, Houston, Oakland, California and Chihuahua, Mexico. Closures are also manufactured in England by ViseGrip Products, Limited, of Liverpool.

Rieke believes it was the first to use all-steel plugs with five full threads, the first to offer a tamper-proof cap seal, the first to produce electro-galvanized flanges and plugs, now standard in the industry.

When World War II increased both demand and service requirements for drum closures for petroleum products, Rieke met the challenge by developing "ViseCar" gaskets, made of Hycar synthetic rubber. In similar manner, Rieke adapted polyenthylene plastic to make more resilient, chemical-resistant, "Poly-Seal" gaskets for the chemical industry.

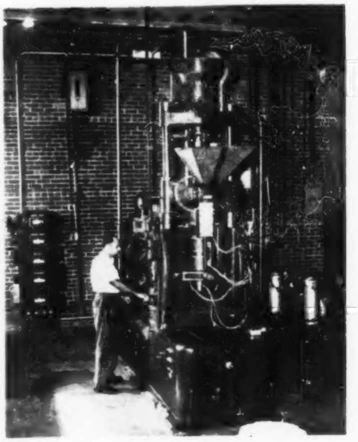
The Rieke cap seal has also been greatly improved. As originally conceived, the chief purpose of this device was to prevent tampering with the drum contents during shipment and storage. But by combining new "flowed-on" gasket materials with specially developed tools, Rieke cap seals now form a hermetic seal against the drum stock, double protection against evaporation and "breathing" of moisture.

Other recent examples of Rieke progress range from improvements such as precision "rolled-on" threads, in place of cut threads, to the new "FlexSpout" closure for steel pails.

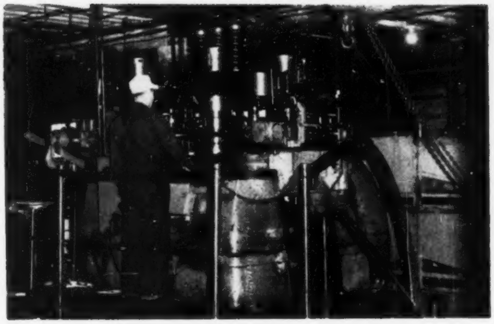
A ViseGrip closure has two principal parts—the flange and the plug. The flange is built into the drumhead by the manufacturer, with Rieke-designed tools and dies. The plug and its gasket seal the drum after filling.

The first step in fitting a drumhead with a ViseGrip closure is to form an embossment in the metal. Quickly, simply, and accurately made, this "pocket" will get its final shape in the important press action that makes the flange an integral part of the drum.

Next, the flange is placed in the embossment. The skirt of the flange is cone-shaped, and has a series of serrations. When the flange and drumhead are pressed together, this coned skirt forces the serrations outward into the drum metal.



A RIEKE EMPLOYEE is shown operating a FlexSpout mold which forms polyethylene closure pouring spouts for five-gallon pails.



A PRESS used for blanking and forming plugs is being operated here.

As the skirt flattens out, the outward force becomes tremendous—actually approaches infinity. The drum metal is drawn and shaped around the serrations, locking the flange inseparably in place.

When the skirt reaches its final flattened position, the press dies flatten the top of the embossment to a broad and smooth surface of drum metal—an ideal seat for the gasket when the drum is sealed.

The flange has now become an integral part of the drumhead. Half of the vise has been built into the drum.

When the plug is run into the flange, it clamps the drum and gasket in a vise-like grip. The gasket is forced against the flat drum metal on one side, the flat under-surface of the plug on the other. The highest pressure is applied where it does the most good—on either side of the gasket. The ViseGrip closure is the strongest and most leakproof part of the drum.

With Rieke ViseGrip closures, the flange to drum metal seal is unimportant. One gasket, bearing on broad, easily-sealed surfaces, does the entire job.

PEOPLE in the Industry

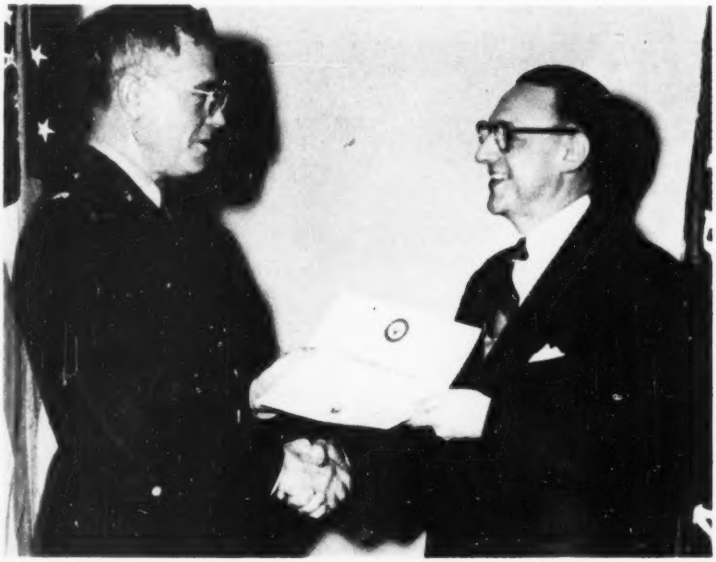
EARL T. RUNCIE APPOINTED TO WITCO POSITION

Witco Chemical Company announces the appointment of Earle T. Runcie to the position of manager of the Purchasing Department for Continental Carbon Company, Continental Oil Black Company and Barnhart Hydrocarbon Corporation.

Prior to his appointment, Mr. Runcie was vice-president of the Belvend Manufacturing Company of Chicago. During World War II, he was associated with the U. S. Army Ordnance Department as a procurement engineer and chief of the Priorities Expediting and Disposal Board.

Mr. Runcie is a graduate of Purdue University with a degree in mechanical engineering. He will be located in the company's Amarillo offices.

MAIER RECEIVES APPRECIATION AWARD



CERTIFICATE OF APPRECIATION AWARD is presented to Curtis E. Maier, of Continental Can Company, by Col. Thomas F. Joyce.

Curtis E. Maier, general manager, Research Division of Continental Can Company, was presented with a Certificate of Appreciation Award by the Department of the Army for patriotic civilian service to the United States during World War II. The certificate, signed by Hon. Frank Pace, Secretary of the Army, was presented to Mr. Maier by Col. Thomas F. Joyce, Chief of the Illinois Military District, Navy Pier, Chicago, Illinois, on January 16.

Specifically, the award is for services on "The Technical and Industrial and Intelligence Committee, Joint Chiefs of Staff, World War II." From June 17 to August 1, 1945, Mr. Maier was assigned to make a complete investigation of the methods and material employed by leading can manufacturing companies in Germany, particularly during World War II.

Special emphasis was placed on the manufacture of cans from black plate or other substitute materials used for the conservation of tin and steel, since it was known that the Germans had been investigating this problem since World War I. This was particularly true since Germany had been on a policy of self-sufficiency between World War I and World War II, and had investigated the uses of substitute metals, synthetic resins, synthetic rubber seaming compounds, and others. Included in this survey were investigations of suppliers of raw materials as well as the activities of the can manufacturers themselves.

Also, investigations were made of composite containers and of all paper containers which were being employed as conservation methods for steel as well as tin. Whenever a development observed appeared to be new or novel or was felt to be important or particularly interesting, an effort was made to present the subject objectively and as completely as possible so that others reading the final report would be able to draw their own conclusions.

HERE IS YOUR . . .

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PEOPLE IN THE INDUSTRY

EMERY CONTEST WINNER ANNOUNCED

H. D. ARMITAGE, Emery's District Manager, is presenting a leather two-suiter to the winner of the Emery naming contest, Mr. Moreau of Corn Products Sales Co. In the background is R. J. Roberts of the Sales Staff.

The winner of the contest sponsored by Emery Industries at the recent Chemical Industries Exposition in New York is:

Philip C. Moreau
Technical Service Representative
Corn Products Sales Company
17 Battery Place
New York

The contest involved the naming of the Emery ball-man trademark currently being used. The winner was selected by Ruthrauff & Ryan, advertising agency of Emery Industries, on the basis or originality and connection with Emery products.

Emery's New York District Manager, H. D. Armitage, presented Mr. Moreau with the leather two-suiter luggage that was displayed at the Exposition.

RICHARD K. HUEY PLANS TO ENTER BUSINESS FOR HIMSELF IN TULSA

Richard K. Huey, well-known figure in oil production circles, has announced that he is entering business for himself in Tulsa, Oklahoma, as a petroleum consultant and gas company owner.

The long-time production vice-president of Deep Rock Oil Corp., will open offices in the Atlas Life Building to carry on his new activities. He will conduct an advisory and management service for oil and gas development and operation. This includes representing non-operating partners in oil and gas production operations.

In addition, Mr. Huey is organizing the Cimarron Gas Co., which will operate a gas transmission system in Payne and Lincoln Counties, Oklahoma. This gas system supplies Deep Rock's Cushing refinery and other industrial and private accounts. The Cimarron system has approximately 50 miles of line and receives gas from a number of fields along its route.

Mr. Huey has been identified with Deep Rock production activities for 31 years. In his work with that company, he was a pioneer in the electrification of drilling and producing oil properties in Mid-Continent fields.

Mr. Huey is a member of the American Institute of Mining and Metallurgical Engineers, American Petroleum Institute, Mid-Continent Oil and Gas Association, Independent Petroleum Association of America, and the Tulsa Club. His new business address will be 409 Atlas Life Building, Tulsa.

G. L. RATCLIFFE ELECTED TO A VICE-PRESIDENCY AT NATIONAL LEAD COMPANY

George L. Ratcliffe, one of the best known executives in the oil field service industry, has been elected a vice-president of National Lead Company, according to an announcement by J. A. Martino, president. Mr. Ratcliffe has been a director of National Lead Company since 1948 and general manager of the Baroid Sales Division of the company since 1929. Baroid is a producer of oil well drilling mud products and testing equipment.

Mr. Ratcliffe joined National Lead in 1929. At that time he was president and general manager of the California Talc Company, one of the predecessor companies to the present Baroid Sales Division. Prior to the organization of California Talc, he also saw service with Standard Oil Company of New Jersey, Texas Pacific Coal and Oil Company and the General Petroleum Corporation.

Industry NEWS

FOOTE STOCKHOLDERS MAKE TV "TOUR"

THIS TV CAMERA and three others at strategic locations "conducted" more that 200 Foote stockholders on a streamlined 45-minute tour of the company's 81-acre Exton, Pennsylvania, plant and other holdings.

Television chalked up another "first" February 22, with its use by the Foote Mineral Company, developers and processors of rare mineral ores and chemicals, to implement an annual stockholders' meeting at the company's main plant.

By means of television, more than 200 Foote stockholders were able to make a streamlined "tour" of the Exton plant, inspect new facilities, and witness key operations at the company's new Kings Mountain, N. C., holdings without leaving the plant cafeteria in which the meeting was held.

The portable TV gear employed, which was installed and operated by RCA Victor, comprised the most extensive closed-circuit system yet installed for a service of this type; the gear was valued at more than $80,000.

Four image orthicon field cameras were set up in strategic and widely separated locations on the 81-acre Foote property. Twelve 17-inch RCA Victor receivers were placed in the cafeteria, and a central control and monitor station was installed in a near-by plant building.

The use of television obviated the necessity for long treks from one key operation or new installation to another, and afforded the stockholders a clearer and more concise picture of the overall operation of their company than they could have obtained by actually touring the area.

The plant tour was "conducted" by L. G. Bliss, Foote vice-president in charge of sales, who was brought to the TV screens by a camera trained on his temporary headquarters in the monitor station as he supplied the introductions and continuity needed to relate the several sequences of the program.

STEWART-WARNER ANNOUNCES THREE MODELS OF OIL PUMPS FOR AUTOMATIC TRANSMISSION

Three models of automatic transmission oil pumps, each designed with the Alemite-engineered filter in the nozzle at the point of delivery, have been announced by the Alemite Division of Stewart-Warner Corporation.

The filter is said to assure delivery of clean fluid to the estimated eight million cars on the road today using automatic transmissions—which will use an estimated nine million gallons of automatic transmission fluid per year.

Besides the filter, Model 7076, which matches other units in the Alemite "Visidrum" line, features delivery through a meter which registers in quarts. The seven-foot hose with six-inch knurled handle, is equipped with a flexible extension nozzle which fits all cars, eliminating adapters. Protection against drippage is claimed for the positive manual shut-off, another feature of these models. An air eliminator is believed to give accurate delivery regardless of the level of the fluid in the container. This model is equipped with a white enamel cover for the drum. The container is moved into position for use on a dolly fitted with four large Bassick casters.

Model 8121, which harmonizes with other shielded equipment in the Alemite "Marshall" line, is equipped with all of the features of Model 7076 plus push-pull handles on the sides of the shield.

Model 7039 is especially designed for use with bung-type drums. The pump fits into the 2-inch p. t. bung of a 15-gal. drum and has all of the features of the other two models with the exception of the cover for the drum.

FUTURE MEETINGS of Your Industry

MARCH, 1952

18-20 Ohio Petroleum Marketers Assn. (annual convention and marketing exposition), Deshler-Wallick Hotel, Columbus, Ohio.

19-21 American Petroleum Institute (Division of Production, Mid-Continent district), Hotel Broadview, Wichita, Kans.

27-28 Texas Independent Producers & Royalty Owners Assn. (6th annual meeting), Hotel Texas, Fort Worth, Texas.

31 to Apr. 2 Western Petroleum Refiners Assn. (annual meeting), The Plaza Hotel, San Antonio, Tex.

APRIL, 1952

1-4 Greater New York Safety Council, Inc. (22nd annual safety convention & exposition), Hotel Statler, New York, N. Y.

2-4 American Petroleum Institute (Division of Production, Eastern district), Hotel William Penn, Pittsburgh, Pa.

7-9 American Society of Lubrication Engineers (7th annual meeting and lubrication show), Hotel Statler, Cleveland, Ohio.

16-18 National Petroleum Association (semi-annual meeting), Hotel Cleveland, Cleveland, Ohio.

21-23 American Petroleum Institute (Division of Transportation, products pipeline conference), The Blackstone, Fort Worth, Texas.

21-24 American Petroleum Institute (safety & fire protection committees), Hotel Texas, Fort Worth, Texas.

21-24 Socy. of Automotive Engineers (national aeronautic meeting and aircraft engineering display), Hotel Statler, New York, N. Y.

24-25 American Petroleum Institute (Division of Production, Rocky Mountain district), Gladstone Hotel, Casper, Wyo.

28-30 American Oil Chemists' Socy. (spring meeting), The Shamrock, Houston, Texas.

MAY, 1952

12-15 American Petroleum Institute (Division of Refining, 17th midyear meeting), St. Francis Hotel, San Francisco, Calif.

14-19 National Tank Truck Carriers, Inc. (4th midyear meeting), del Coronado Hotel, Coronado, Calif.

15-16 American Petroleum Institute (Division of Production, Pacific Coast district), The Biltmore Hotel, Los Angeles, Calif.

19-20 American Petroleum Institute (Division of Marketing, midyear meeting), The Sheraton Plaza, Boston, Mass.

21-23 Oil Industry Information Committee, St. Francis Hotel, San Francisco, Calif.

JUNE, 1952

1-6 Socy. of Automotive Engineers (summer meeting), Ambassador and Ritz-Carlton, Atlantic City, N. J.

5-6 Pennsylvania Grade Crude Oil Assn. (annual meeting), Hotel William Penn, Pittsburgh, Pa.

8-12 Canadian Gas Assn., Chateau Frontenac, Quebec City, Quebec, Canada.

9-10 Chemical Specialties Mfrs. Assn. (38th midyear meeting), Hotel Statler, Detroit, Mich.

9-13 National Fire Protection Assn. (annual meeting), Hotel Statler, New York, N. Y.

9-14 American Petroleum Institute (Division of Production, midyear standardization conference), Brown Palace Hotel, Denver, Colo.

JUNE, 1952

19-20 American Management Assn. (general management), Waldorf-Astoria, New York, N. Y.

23-27 American Socy. for Testing Materials (annual meeting), Hotel Statler, New York, N. Y.

23-27 American Inst. of Electrical Engineers (summer general meeting), Nicollet Hotel, Minneapolis, Minn.

AUGUST, 1952

11-13 Socy. of Automotive Engineers (national West Coast meeting), Fairmont Hotel, San Francisco, Calif.

19-22 American Inst. of Electrical Engineers (Pacific general meeting), Westward Ho, Phoenix, Ariz.

SEPTEMBER, 1952

9-11 Oil Industry Information Committee, The Traymore, Atlantic City, N. J.

9-11 Socy. of Automotive Engineers (national tractor meeting), Hotel Schroeder, Milwaukee, Wisc.

10-12 National Petroleum Assn. (50th annual meeting), The Traymore, Atlantic City, N. J.

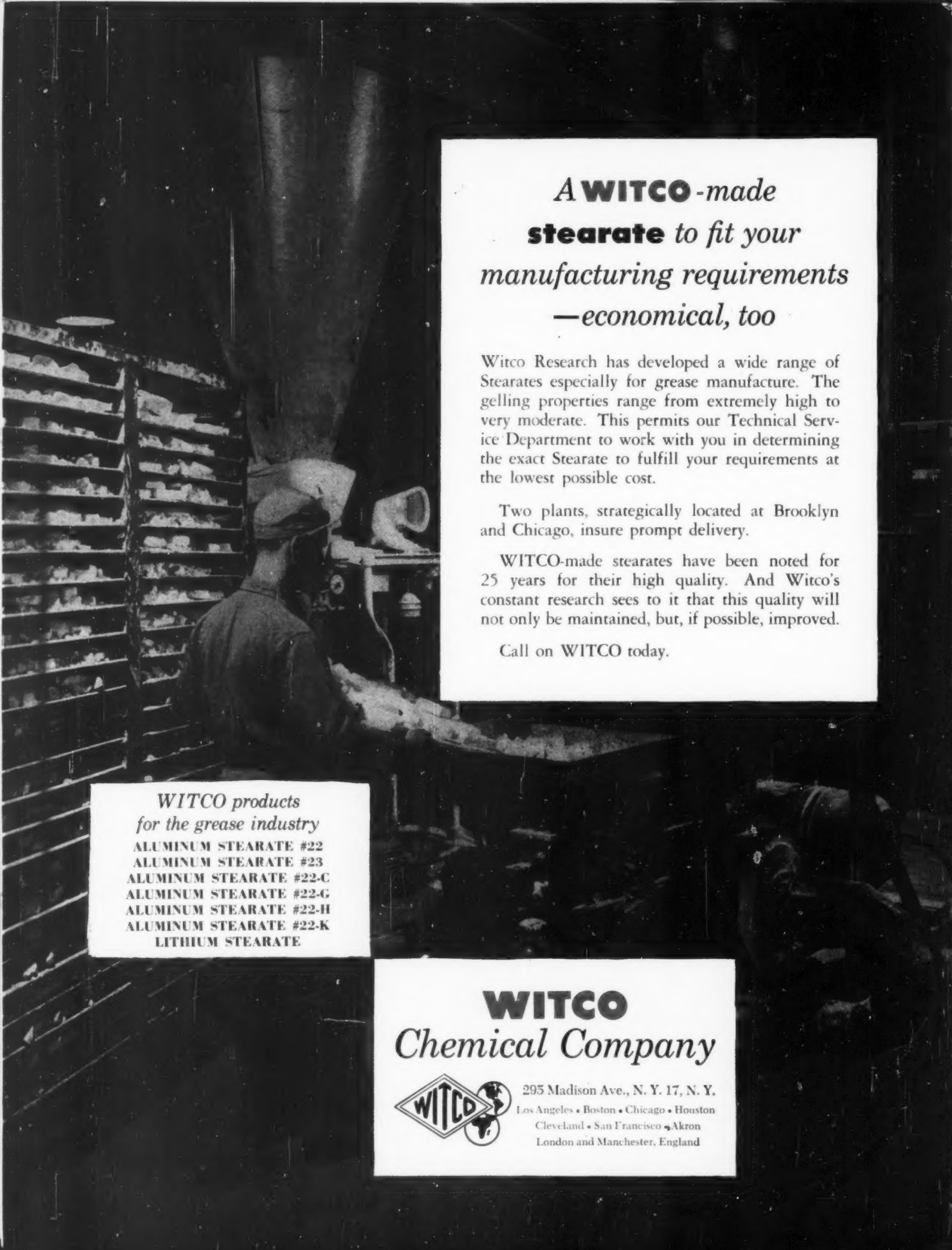
22-24 American Trade Assn. Executives (annual meeting), Royal York Hotel, Toronto, Ontario

OCTOBER, 1952

1-4 (tentative) Socy. of Automotive Engineers (national aeronautic meeting and aircraft engineering display), New Hotel Statler, Los Angeles, Calif.

5-8 Controllers Inst. of America, Hotel Statler, Detroit, Mich.

27-29 National Lubricating Grease Institute (20th annual meeting), Edgewater Beach Hotel, Chicago, Ill.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